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ABSTRACT

This "state of the art" paper is intended to provide researchers, curriculum development specialists, and practitioners with an authoritative analysis of the literature in the field. Major sections include: (1) Background and Structure, (2) Resource Materials, (3) Sources of Content Information for Analysis, (4) Types and Techniques of Analysis, (5) Translating Content into Courses of Study, (6) Building Curriculum from Analysis, (7) Systems Approach to Building Vocational Curriculum, and (8) Trends and New Directions. It was concluded that more serious considerations must be given to: (1) increasing the use of analysis as the foundation for vocational curriculums, (2) codifying and defining terms used, (3) developing common understandings of effective processes of analysis, and (4) accepting procedures found to be functional by other vocational services. A suggested approach to providing validated vocational curriculums would be the establishment of a center(s) for the unique purpose of curriculum building. Such a center would need: (1) a competent staff with command of the total process of analysis and curriculum building, (2) hardware, including computers and software, and (3) effective dissemination methods. (JK)

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review and synthesis of research:

Analysis for Curriculum Development In Vocational Education

ERIC Clearinghouse
THE CENTER FOR VOCATIONAL AND TECHNICAL EDUCATION
THE OHIO STATE UNIVERSITY, 1900 Kenny Rd., Columbus, Ohio 43210

The Center for Vocational and Technical Education has been established as an independent unit on The Ohio State University campus with a grant from the Division of Comprehensive and Vocational Education Research, U. S. Office of Education. It serves a catalytic role in establishing consortia to focus on relevant problems in vocational and technical education. The Center is comprehensive in its commitment and responsibility, multidisciplinary in its approach, and interinstitutional in its program.

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REVIEW AND SYNTHESIS OF RESEARCH: ANALYSIS FOR CURRICULUM DEVELOPMENT IN VOCATIONAL EDUCATION

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October 1969

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PREFACE

This *Review and Synthesis of Research: Analysis for Curriculum Development in Vocational Education* is one of a series of "state of the art" papers in vocational and technical education and related fields. It should assist in identifying substantive problems and methodological approaches for researchers and curriculum development specialists, as well as providing practitioners with a summary of research findings which have application to educational programs. In the field of vocational and technical education, the pace of research and development activities has increased considerably during the period under review. Gaps which exist for some readers are probably the result of the author's prerogative to be selective.

As one of a series of information analysis papers released by the ERIC Clearinghouse on Vocational and Technical Education, this review is intended to provide researchers, curriculum development specialists, and practitioners with an authoritative analysis of the literature in the field. Those who wish to examine primary sources of information should utilize the bibliography. Where ERIC Document numbers and ERIC Document Reproduction Service prices are cited, the documents are available in microfiche and hardcopy forms.

The profession is indebted to Milton E. Larson for his scholarship in the preparation of this report. Recognition is also due Bruce W. Tuckman, Associate Professor of Education at Rutgers University; Elizabeth Simpson, Chairman of Home Economics Education, University of Illinois; George Luster, Director of Vocational Education, University of Kentucky; and Gordon G. McMahon, Director of the Division of Vocational Technical Education at the State University of New York, for their critical review of the manuscript prior to its final revision and publication. Joel Magisos, information specialist at The Center, coordinated the publication's development.

Members of the profession are invited to offer suggestions for the improvement of the review and synthesis series and to suggest specific topics or problems for future reviews.

Robert E. Taylor
Director
The Center for Vocational and
Technical Education

INTRODUCTION

During the period since the Second World War, renewed interest has been exhibited in the role of analysis for curriculum development. With the development of a highly complex world of work and the rapidly changing nature of many jobs has come the realization that education for employment must be geared to the needs of the employer. To achieve this goal, the knowledges, skills, habits, and attitudes essential for securing and holding a job must be determined.

Job and task analysis has been given tremendous impetus by the concentrated effort of the three main branches of the Armed Forces. Refinement of the method and development of the systems approach can be listed among major contributions of such research efforts. In addition, field testing and application to all types of jobs and positions have advanced knowledge of applications on a large scale.

The Division of Employment Security of the Department of Labor has made a major contribution to the field of analysis. The *Dictionary of Occupational Titles* with the two recent supplements represents an outstanding accomplishment in the field of analysis. The methods used as well as the knowledge gained provide a significant advance in the forward movement of analysis.

A number of psychologists, as well as researchers in the field of vocational and technical education, have concentrated time and talent in this field.

The materials reviewed have been gathered from many sources. *Research in Education* (ERIC) as well as *AIM* and *ARM* were extremely helpful. All 50 RCU directors were contracted as well as approximately 150 individuals engaged in research at such institutions as universities, colleges, state departments, Armed Forces, public agencies, and private organizations.

Every effort has been made to include significant research findings and other recognized contributions to the field contained in reports, books, periodicals, manuals, and guides.

In making this review a number of curriculum guides were reviewed. Only these were included which contributed to analysis. Many curriculum guides failed to identify their sources of information.

While, in the main, the review concentrated on research and writing since 1963, in some cases it was felt that previous works were needed as references to identify more clearly a particular trend or to provide meaningful background.

A number of studies were reviewed but omitted as they contained little information on analysis for curriculum building.

The structure of the topical organization is provided in the Table of Contents.

To all who contributed materials for review or assisted in any way, the author wishes to express his appreciation.

Milton E. Larson

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REVIEW AND SYNTHESIS OF RESEARCH: ANALYSIS FOR CURRICULUM DEVELOPMENT IN VOCATIONAL EDUCATION

BACKGROUND AND STRUCTURE

Curriculum development based on employment needs is the essence of effective payroll education for the youth and adult in today's world. The climate of both society and recent legislation has highlighted the base line essential for solutions to problems relative to the world of work for individuals and the nation. Curriculum development, in the Amendments to the Vocational Education Act of 1963, has been identified as a needed force. The real thrust of building curriculum for vocational instruction is found in analysis of occupations. Requirements of the employers are essential to identifying content for occupational and vocational education. Interpretation of the employer's needs of today for tomorrow's program of vocational education to meet the requirements of the employers is more complex – but highly significant in today's changing technological civilization.

Early Approaches and Current Concepts

Job analysis has been used for many years. In fact, Comenius, a Russian, believed youth would discover their special aptitudes if they were given instruction in handwork along with academic subjects. Comenius lived during the seventeenth century. Pestalozzi established an educational system built around farming, spinning, and weaving, in the latter part of the eighteenth century. In 1750 Benjamin Franklin started an academy in Philadelphia where instruction was given in the trades. Otto Saloman of Sweden refined the Sloyd system by focusing attention on the analysis of operations and the educational method as well as on making useful objects (Wimer, 1968). Charles R. Allen in *The Instructor, The Man and The Job* identified and discussed the importance of job analysis for curriculum construction in vocational education.

A principle directly related to job analysis became firmly established during the early formative years of vocational education. This principle stated that in order to provide for the development of originality, initiative, and real thinking and also to prevent learning by rule of thumb, the teaching should be almost entirely through jobs, questions, problems, and guided discussions. The process consisted of first making a list of jobs and then connecting the technical terms and other related information with these jobs (Wimer, 1968).

Even though analysis had its beginning long ago, one of our recent writers (Martin, 1966) stated, "It is our belief that the problem beneath the present under-utilization of manpower lies in the fact that the analysis and grouping of jobs available according to skills and abilities have been ill-defined and haphazard." A report of a recent world-wide conference recorded agreement by participants that "the establishment of educational research and development of pilot projects with the operations analysis approach should be investigated" (Stoller, 1966). In discussing the role of analysis, occupational data, and educational planning, another authority stated that educational planning is largely a state and local function but the skills acquired in our schools are frequently sold in the national market.

There is a need for more information about patterns of occupational mobility (Levitan, 1965).

Successful structures for learning are determined in the occupational field on the basis of analysis (Morrison, 1966a). Such structures need to define essential, sequential relationships and provide for acquisitions of capabilities in relevant content.

Today's world demands constant job redesigning. An effective approach to job redesign involves applying information gained by analysis. In a recent paper (Lewis, 1968), the significance of the worker-traits analysis technique, developed by the United States Employment Service, was explained.

The present educational predicament is reflected in the following quotation: "An analysis of most so-called comprehensive high schools today would show that neither the present college preparatory program, the present vocational or industrial arts program, nor the present general or "cafeteria style" non-college preparatory program provides satisfactory preparation for the great range and rapidly diversifying set of post-secondary school opportunities. . . ." (Lessinger, 1965). In part this defect is related to curriculum. How is curriculum information derived?

The Role of Analysis

Curriculum builders in vocational and technical education are looking with renewed emphasis to job analysis and task analysis. The literature indicates this fact. In a recent article (Gray, 1967), it was pointed out that course content in home economics gainful employment is determined by a job analysis of what the worker must know and be able to do to be successful in the occupation for which he is trained. A writer in the field of agricultural education (Drawbaugh, 1966) emphasized that of the several means of obtaining occupational training information, job analysis is one of the best known. He explained that when complete job-analysis data are utilized to write a training course, the course is aimed at occupational training objectives rather than toward the traditional core of subject matter. Another guide, developed for machine shop, stressed that the shop program must be planned around an analysis of the occupation (*A Guide to the Development of a Course Outline for Machine Shop,* 1968).

The role of analysis is further developed (Lessinger, 1965) through the practical interpretation of statements such as, ". . . underlying all the professional, skilled, and technical occupations, lies a substantial set of behaviors which can be taught, described, and are remarkably stable." The approach to such stability was identified and developed into twelve observable, definable, and teachable stages for the Aerospace Pre-Technical Training Program at Aragon High School (Lawson, 1967).

An effective technical training program has five basic requirements as delineated in a paper presented to the National Society of Programmed Instruction (March, 1963). These are: job specification, translation of job specification into training objectives, measurement of the individual's aptitude for training, development of a method of achieving the training objective, and performance control and evaluation.

Jeffrey and Tancy, 1967, define job analysis as the process of studying the operations, duties, and organizational relationships of jobs to obtain data for writing job descriptions and job specifications. Another writer (Morsh, 1964) describes job analysis as the collection and interpretation of information about work performed. A third person (Drawbaugh, 1966) cites the definition in the Department of Labor's *Training and Reference Manual for Job Analysis* which describes job analysis as the process of identifying by observation, interview, and study of the technical and environmental facts of a specific job and reporting the significant workers' activities and requirements. While many other definitions and descriptions have been developed, these establish a frame of references for some of the salient aspects of building curriculums for occupational education.

Building Curriculum for Pay-Check Education

The importance of meaningful curriculums for vocational education at the high school level based upon the facts of employment requirements was presented in a comprehensive study by the Division of Vocational Education, Department of Education for Alaska (Beima, 1967). A comprehensive study (Altman, 1966) developed and verified the methods of deriving capabilities from job information. This study was based on a sample of thirty-one occupations selected because of anticipated major employment opportunities during the coming decade. A random sample of task behavior was drawn for each occupation and each selected behavior was translated into a multiple-choice type questionnaire. The findings of this study are significant for curriculum builders. It indicates that there is a definable and well-structured domain of vocational capabilities which has not previously been well defined and which is not being systematically taught by our education institutions.

The implications of the large number of definitions and applications of curriculum (Cay, 1966) suggest the need for careful consideration in the approach used. Five dimensions for curriculum development (Olivo, 1964) should be noted: vertical coordination, horizontal articulation, depth of programming and methodology, outer space, and the probing for the new.

An innovative approach to curriculum has been described as the organic curriculum (Morgan and Bushnell, 1965). This proposal calls for radically modifying the system in order to design an educational program which will be responsive to the present-day needs of students. Such a program would include academic and occupational training, personnel development, real work experience, personal and vocational counseling, and social and recreational activities. The integration and interaction of these components would be a result of careful system design. The curriculum would be learner-oriented, and each activity would be related logically to all other activities and lead to the efficient attainment of behavioral goals. The investigators suggest that the first step in building such a student-centered curriculum is to study those behavioral attainments needed by the individual for entry into a variety of post-high-school activities. They emphasize the importance of describing specifically and precisely the learning experiences would lead to the desired behavioral outcomes. This denotes careful analysis.

Some of these same features are identified in the study *Development and Evaluation of an Experimental Curriculum for the New Quincy (Mass.) Vocational-Technical School* (Butler, Seager, and Loch, 1968). The principal goal of this project was to demonstrate increased effectiveness of instruction when content is explicitly derived from analysis of desired behavior after graduation. This project sought to apply newly developed educational technology to the design, conduct, and evaluation of vocational education. The complex nature of the world of work is reflected in new innovations in design, organization, and production which has frequently resulted in a systems approach.

Integrated Learning Systems

Curriculum building in occupational education is rapidly assuming the systems approach. Authors of a recent article (Tracey, Flynn, and Legere, 1968) suggest that systems thinking as applied to the improvement of military training programs can be used to upgrade instruction in vocational education. They point out that the systems approach, which attempts to combine human and material resources, requires a control model for proper management. According to the article, this model has reduced, over the four-year period of refinement, on-the-job training time, cut academic failures, improved teaching efficiency, and lessened the over-all training time. The cycle starts by analyzing market needs and ends by evaluating the student after graduation. There are three major phases in the cycle: determination of system requirements, system development, and system validation.

A major thrust has been made by the Armed Forces in the application of the systems approach to vocational instructional programs. Such a system of collecting, analyzing, and interpreting work requirements data and building it into curriculum has been designated by the acronym, SAMOA, which stands for Systematic Approach to Multidimensional Occupational Analysis. The central concept of this approach is that an area of occupational specialization has three dimensions: technical, organizational, and communicational. In a well planned study (Carr, 1967) the method and approach used were described. This method may be characterized by a multidimensional approach which stressed the total work situation, and a set of quantitative computerized techniques for the application of this approach. The study demonstrated that the SAMOA method is technically feasible for determining current work requirements.

Another research project (Butler and Coit, 1967) related to the Job Corps, reported that the systems approach involved the accurate identification of the requirements and problems, the settling of specific performance objectives, the application of logic and analysis techniques to the problems, the development of methods for the solution of the problems, and the rigorous measurement of results compared with the specific performance objectives. Again, it was emphasized that good instructional design demands careful analysis of the content for the training program. The investigators found that the validity of course design was directly related to the accuracy of the task analysis.

Summary

Job analysis was recognized as early as the seventeenth century as a desirable approach for developing content in vocational education. A few applications of the process were found in vocational education programs closely related to industry. Increasing use of the process by other services of vocational education was evident. The movement was strengthened by some vocational educators who were dedicated to the concepts and through the research of a few investigators employed by universities, the Armed Forces, the Employment Service, and the Job Corps.

RESOURCE MATERIALS

The accelerated rate of interest in the methodology and applications of job and task analysis has resulted in the production of a limited quantity of recent resource materials helpful to a greater understanding of this field. However, some materials developed a few years ago help meet this need. A few of the materials are general while others focus on specific elements of the total process. These materials reveal a wide variety of approaches. Throughout this review, these are referred to as part of the treatment of the various sections. However, the author believes that the illustration of types of resources materials is appropriate and will be helpful to the reader. Those identified are illustrations of available materials.

Textbooks

In a fundamental textbook for teachers (Fryklund, 1956) the total process of analysis is described and illustrated. The author deals with kinds of analysis, the main emphasis being on job analysis of industrial occupations. The operation is the basic unit of the analysis structure which uses the job and employs the technique of blocking. Distinction is made between the analysis of custom occupations and of service occupations. The author relates the analysis process to the learning process and to course development.

Another textbook (Bollinger and Weaver, 1955) introduces a card system for recording trade content. Emphasis is placed on the flexibility of this system. The ultimate objective of the book is to assist teachers of occupational subjects to discover the teachable content in the specialty and to formulate it into a master course of instruction based on well-known techniques. The book deals with the reasons for analysis, process of analysis, placing the information in the course of instruction, and using the course of instruction as an aid in teaching.

The zoned analysis method is presented in a textbook developed and published by the Denver Public Schools (*A Unit of Instruction, How to Organize It and How to Teach It,* 1962). The zoned analysis is a method of charting identified elements of the occupation in order to better show the relationships of the parts. The textbook uses the vehicle of operation sheets and information sheets to present the elements of the process of analysis. It translates the results of analysis into operation sheets, information sheets, and

other instructional aids. The zoned analysis approach is used with the content analysis method to produce a graphic outline of the job types to be utilized in the instructional program and the operations and information topics to be taught.

Another author (Friese, 1958) lists ten steps in making a course of study. The second step is analyzing the occupation or course area for manipulative skills and related content. Included is a brief plan of analysis with forms for completing the process. The author includes the history of analysis and compares the occupational analysis method of Allen with that of Selvidge.

A recent textbook (Giachino and Gallington, 1967) emphasized the adequacy of the educational plan with proper instructional organization. Analysis is described as a technique for making an inventory of all the learning activities that are associated with a specific instructional area. It emphasizes that analysis not only insures complete coverage of the important teachable elements but it also makes possible the arrangement of these elements into a logical teaching order. It describes five steps in the analysis function: list the manipulative activities, list the "knowing" units, designate the media of instruction to be used, specify definite activities which contribute to the learning process, and identify the instructional aids.

Handbooks and Manuals

A most significant contribution to the methodology and literature of occupational analysis was made by the U.S. Employment Service (*Dictionary of Occupational Titles,* 1965). The information was obtained primarily by job analyses involving direct observations of and interviews with workers; consultations with supervisory personnel, or both; and the utilization of data from such sources as employers, trade associations, labor organizations, professional societies, and public employment offices. The third edition presented an improved classification system and reflects relationships among jobs. Eight classification components were selected for these purposes: training time, aptitudes, interests, temperaments, physical demands, working conditions, industry, and work performed. Volume I of the third edition contained names and definitions of the various occupations in the economy arranged alphabetically according to job titles. Defined are 21,741 separate occupations which are known by 13,809 additional titles, making a total of 35,550 defined titles. Volume II contained an arrangement of jobs according to occupational, industrial, or worker characteristics and provided detailed information about worker traits.

In a supplement to the *Dictionary of Occupational Titles* (*Selected Characteristics of Occupations,* 1965) are listed the individual physical demands, working conditions, and training-time data for each job defined in the Dictionary. These characteristics reflect information obtained by job analysis at the job site.

In a second supplement to the *Dictionary of Occupational Titles* (*Selected Characteristics of Occupations by Worker Traits and Physical Strength,* 1968) the data on physical demands, working conditions, and training time for each job defined in the Dictionary are arranged by worker

trait groups of the occupational classification structure. The supplement used together with the Dictionary will permit better interpretation and evaluation of selected significant job characteristics for a wide range of occupations requiring similar traits and abilities.

Helpful for individuals planning to make job, task, or occupational analysis is the U.S. Bureau of Employment Security manual (*Training and Reference Manual for Job Analysis,* 1965). The manual was prepared in the Branch of Occupational Analysis under the direction of Leon Lewis. It emphasizes the three parts to the analysis of any job: The job must be identified completely and accurately, the tasks of the job must be described completely and accurately, and the requirements for successful performance must be indicated. There are four categories of information for a complete analysis of a job: what the worker does, how he does it, why he does it, and the skill involved in doing the job. The manual provides excellent descriptions of the analysis process with definitions and explanations of the main terms used.

Useful for the job analyst is a small guide (*Guide for Analyzing Jobs,* 1966) available from the U.S. Superintendent of Documents. This guide is divided into three major sections. The what, the how, and the why are contained in the first section; the skill involved in the second section; and the physical and training requirements of workers in the third section. This guide is a workbook designed to be completed by the analyst as he studies the job.

George H. Andrews Engineering Associates, Incorporated, prepared a basic manual for use in a training course in job analysis (*Job Analysis,* 1960). While this manual is specifically directed to the training of people for job analysis in personnel practices, it is helpful for individuals making occupational analysis for curriculum development.

A publication of the Job Corps Civilian Conservation Centers (*Work-Vocational Training Manual,* 1968) provides information for building coordinated training programs. This manual outlines the steps in the analysis process as first, identification of occupational skills and second, identification of vocational training opportunities.

Guides

A number of guides have been prepared by state agencies as well as the Federal government to assist educators in making occupational analysis. One of these is described as a leader's manual for executive and supervisory personnel in distributive occupations (Kneeland, 1964). The manual deals with: introduction to job analysis, preparation of job analysis forms, techniques of collecting information, processing information, and putting the job analysis to work. Another guide for people is distributive education was developed for the State Department of Education in Florida (*Organization and Operation of Distributive Education Programs for Adults,* 1966). This guide states that the needs, interests, and abilities of the class should form the basis for developing the curriculum. The instructor should determine what the student must know and then formulate the secondary objectives.

Another guide was written particularly to assist instructors in Manpower Development Training programs (McDonough, 1968) in building the course of study. Four steps are delineated: first, analysis of trade and jobs; second, course outlines; third, instruction sheets; and, fourth, lesson plans. The purposes of the course analysis are identified as: breaking up course content into large blocks, breaking each block into units, and then organizing the units into usable, practical teaching sequence applying psychological laws of learning. Flow charts and instructional sheets are illustrated.

Typical of a series of guides developed for the U.S. Office of Education is the publication *Electronic Data Processing in Engineering, Science, and Business* (1965), designed to provide suggested techniques for determining courses of study in vocational and technical education programs. This publication indicates how job analysis and job relationship techniques can be used to facilitate the planning of training programs. It stresses the fact that before technical curriculums can be established, the individual occupations for which training is needed should be identified. Then it describes the second step as the analysis of each of the jobs and the preparation of brief job descriptions covering the typical work activities, functions, and performance requirements for each occupation. The author continues by stating that occupations should then be arranged in homogeneous groups or clusters, and the kind and amount of basic and applied science, mathematics, and technical know-how required to prepare workers to perform the duties of each job should be specified. Training curriculums which grow out of such analyses and groupings are commonly called "cluster-based" curriculums.

A very helpful guide was developed by the U.S. Naval Training Device Center (Chenzoff, and Folley, 1965) for training in situation analysis. Three phases of Training Situation Analysis (TSA) are described: systems familiarization, task analysis method, and training analysis procedure. Systems familiarization provides an orientation to the training problem, the system structure and flow, and the equipment. Task analysis method produces a set of task descriptions containing the information necessary for making training device decisions. Training analysis procedure produces a ranking of tasks based upon the potential benefit to system performance as a result of training and the cost of that training.

Reports of Workshops

A one-week workshop for state directors, state supervisors, and vocational teacher educators was sponsored by the U.S. Office of Education at Colorado State University (Larson and Blake, 1969) on occupational analysis as a basis for curriculum development. Papers were presented by twenty-one guest instructors on both fundamental and innovative topics of occupational analysis. Included in the institute program were such topics as zoned analysis, content analysis, curriculum planning, the U.S. Employment Service approach to analysis, the cluster concept, the "PERT" process, and curriculum development for the disadvantaged.

Another workshop conducted at Michigan State University focused on the development of instructional materials for food-service occupations (Hollandsworth and Barbour, 1966). The objectives of this workshop included analyzing food-service occupations, development of instructional guides, and development of methods suitable for analysis of these occupations.

Two of the units in the report of a workshop held in Texas (*Report of Second Annual Workshop for Coordinated Vocational-Academic Education,* Unit Three, 1968a; *Report of Second Annual Workshop for Coordinated Vocational-Academic Education,* Unit Six, 1968b) provide practical information on the applications of analysis for vocational education. In Unit Three the evolution of instructional material is outlined. The report identifies this evolution as beginning with trade analysis and progressing through the development of the course outline, instructional materials, and terminating with the completion of the progress record. Unit Six provides a very helpful glossary of terms such as, analysis, job analysis, trade analysis, block, job, and task.

Papers

Among the several papers available on the subject of job and task analysis, two have been selected for inclusion in this section to illustrate the nature of content available. One paper (Martin and others, 1963) deals with manpower projections of scarcity, quality, and obsolescence and relates job analysis as an important dimension in dealing with these problems. Another paper (Martin, 1966) points out that job data must be viewed in terms of the underlying structure of the data and the purpose to be served. In addition to the applications of analysis for curriculum construction, the paper emphasizes the need for categorizing job data for counseling and for decision-making.

Summary

Resource materials are very limited on the subject of analysis for curriculum development. In the main that which has been written reflects a narrow rather than a broad approach. As a result, the frame-of-reference is usually directed to a specific vocational service or occupation. Therefore, individuals seeking understanding of analyses must be willing to accept and be capable of understanding the techniques as developed by those services using the approach. Adaptations to all services are not difficult for those who understand the fundamentals of analysis.

SOURCES OF CONTENT INFORMATION FOR ANALYSIS

Information concerning occupations is derived from two sources, either primary or secondary. For purposes of this review, primary or original sources of information are closely related to those actually involved;

whereas, secondary sources are defined to include textbooks, references, manuals, and articles in periodicals less closely connected to individuals directly involved in the occupation. Mail surveys, interviews, and personal participation of the educator in some form are considered primary sources of occupational information.

One writer (Cay, 1966) explains that there are only three basic referents possible in the development of distinctive curriculum patterns. These referents are: man's categorized and preserved knowledge, namely, subject fields; our society, its institutions, and social processes; and the individual to be educated—his nature, needs, and developmental patterns. While this provides a theoretical frame of references, the vocational educator will secure more assistance from the description of methods of securing current information and evaluation through surveys, interviews, and the involvement of advisory committees as presented in the booklet, *Technician Training Beyond the High School* (Emerson, 1962).

An interesting study on the agreement of workers and supervisors (Madden and others, 1964) revealed an overall 90 per cent agreement in terms of performance or nonperformance of all tasks in the inventory. The investigator concluded that since there was no tendency for subordinates to exaggerate the nature of their jobs, it is preferable to collect job information directly from incumbents.

Mail Surveys

Review of a large number of studies designed to determine content for building curriculum utilizing an analysis base revealed the use of the mail survey. Suggested procedures and techniques for conducting such a study are contained in three publications (*Handbook on Employment Security Job Market Research Methods—Area Skill Survey,* 1965; *Fact-Finding in Vocational Education, A Handbook for Conducting Vocational Surveys,* 1964; and, Roney, 1962). Also, a study with implications for analysis survey techniques as related to shortage and retrieval of information was conducted in California (Harris, 1967).

Several state-wide studies with implications for job and task analysis have been conducted recently. Careful study by vocational educators or researchers planning state-wide studies of this nature will prove helpful. Recommended for this purpose are the studies conducted in Ohio and Kentucky (Shoemaker, 1966; Leslie and Others, 1966). Some insight will be gained by review of recent innovations in the various states (*Innovations and Special Programs in Vocational Education,* 1968).

A position analysis questionnaire study of sixty-eight attributes to 178 elements was recently completed by the Occupational Research Center, Purdue University (Mecham and Others, 1969). The investigation was directed toward the development of a procedure for establishing job requirements on the basis of synthetic or generalized validity. The general approach was to establish validity of job requirements for any given job on the basis of a "build-up" of data on the attribute requirements of the individual job elements (or groups of job elements) that are part of the job. The position

analysis questionnaire (PAQ) is a job analysis instrument that includes 189 job elements of a "worker-oriented" nature. These job elements are of a check list or rating-scale nature.

A course in basic report writing resulted from a questionnaire study (Bowen, 1967) conducted in the Yosemite Junior College District of California. Twenty-one basic skills needed in vocations cited were identified.

Another study with broad implications for curriculum development in higher education was recently completed at Northern Illinois University (Jacobsen and Swanson, 1966).

A very thorough study using a mail-survey approach focused on the adequacy of measurement procedures of two-year post-high school electronics technology courses throughout the United States (Foley, 1967). This study has far-reaching implications for analysis as well as for evaluation.

Four studies relative to the occupations within the Armed Forces provide excellent information for students of occupational analysis who are interested in the survey approach (Morsh, 1965; Carr and Silverman, 1966; Ammerman and Melching, 1966; and, Morsh, 1966).

All the services of vocational education have used mail surveys as a method of securing information for occupational analysis. Some of these studies are intended mainly to secure fundamental information on the basic functions performed in the occupation while others are directed at updating existing information relative to the occupation.

Individuals seeking such studies in agricultural education will find helpful suggestions, methodology, and findings in five recent studies (Jensen, 1964; Jarett, 1967; Loveless, 1967; Rodrigues, 1967; and, Long, 1968).

Six studies reviewed in the field of business and office education used a written questionnaire (Matulich, 1964; Erickson and Oliverio, 1964; Woodin, 1966; Wenner, 1966; Wood, 1967; and Perkins and Byrd, 1967). The study by Perkins and Byrd was extremely well designed with a validated instrument by a jury of experts.

McGraw-Hill Book Company has developed a guide for building survey instruments to gather information for analysis for curriculum construction (*High School and Adult Prep Program Planning Guide for Distributive Education,* 1969).

In home economics, two questionnaire studies were reviewed (Rahmlow and Cavanagh, 1966; and Beavers and Shipley, 1967). Both studies involved data gathering and task analysis involving a cluster of activities in home economics.

In the field of health education, one study (Dickey, 1965) concentrated on data covering the duties of licensed practical nurses; whereas, another statewide survey (Kinsinger and Ratner, 1966) dealt with ten specific health technologies. The latter study was completed in five phases using in addition to the questionnaire a consulting committee. In fact, eleven curriculum study groups were utilized. The outcome was a series of curriculum guidelines for educational programs to be offered by community colleges for training health service technicians.

While reviewed studies in technical education concentrated in two fields, namely, architectural drafting (Wilson, 1968) and electronics (Mills, 1966; Mills and Rahmlow, 1966; and Woode, 1968), the methodology is suitable for all similar studies in technical education. Another study (Murphy and Wahl, 1967) was mainly to determine the need for all kinds of engineering technicians in Lake County, Illinois.

Interviews

Data gathering for analysis by the interview method was found to be a common method, although less frequently used than the mail survey. Two state-wide studies (McComas and Willey, 1966; and *Survey of Information on Vocational and Technical Education in the State of Illinois,* 1966) employed the interview methods.

In a study, *The Identification of Common Behavioral Factors as Bases for Pre-Entry Preparation of Workers for Gainful Employment* (Sjogren, Schroeder, and Sahl, 1967), a correlation matrix was used to analyze eighty-three occupations to identify behaviors common to a number of occupations. In another study (Arnold, 1965), the comparison was made of the concepts of management with that of the technical personnel as to technical curricular content. The investigator used two sets of instruments; an interview schedule and a curriculum deck. The curriculum deck consisted of ninety-nine index cards containing all subjects of course content related to a technician's job performance. Experimental data, comprising responses to the curriculum deck, were used in analyses or comparisons of curriculum recommendations and for the establishment of cores of recommendations.

The interview technique was employed in several studies reviewed in agricultural education. In one state-wide study (Sims, 1966), two interview forms were developed with one being used to record information about specific occupational titles. Another study in this field (Bucknell, 1967) pointed out the new methods and materials essential for effective agricultural curriculums. Competencies needed by the employees of greenhouse operators were identified in still another study (Parsons, Byram, and Lindstrom, 1966). The nature of the work of technicians in agriculture was the focus of a study in California (Donker, 1963). Agricultural technicians were categorized into eleven major areas.

A model for the study of health occupations training pprograms was developed as part of the *Pittsburgh Technical Health Training Institute Demonstration Project* (Kishkunas, 1967). Interviews were conducted with workers and with job specialists. The task-rating charts used also included identification of frequency of performance and the degree of importance of the task. A core curriculum resulted for the analysis of sixty-one tasks common to three occupations.

A free-response questionnaire with interview form was developed for a Florida state-wide study of gainful employment in home economics (Ridley, 1967). One of the purposes of this study was to cluster occupations and to identify the competencies needed in each cluster of occupations. A random sample of 10 per cent of the 256 firms listed in the yellow pages of the

Tallahassee telephone directory was drawn. Similar samples were drawn in twelve other countries in the state.

In a study of auto mechanics in Nebraska (Engelbart, 1968), the interview data collected were transferred to a master table which was helpful in showing the competencies needed by workers in each job title.

The interview method was used in several studies in technical education. One of these (Teel, 1966) focused on competencies of the marine biology technicians, physical oceanographic technicians, and general biological technicians. Another study employed a stratified two-stage cluster sampling technique to determine the competencies needed for technicians in rural areas (Phipps and Others, 1964).

A study to provide a descriptive base for the development of post-high-school programs in distributive education was conducted in Bucks County, Pennsylvania by the interview method (Salisbury, 1966). A systematic sample of twenty-five employers was drawn as the second step of a four-stage study.

Specific knowledge and skills required of persons entering employment as mechanical draftsmen were sought from fifty-four firms in a recent Master's study (Pilotte, 1965). An average of 83.6 per cent of the respondents in each kind of drafting indicated that an introductory knowledge of several drafting specialties was essential for mechanical draftsmen.

A model study to identify the curriculum content for electro-mechanical technology (Roney, 1966) used, in addition to interviews, a written questionnaire and a panel of consultants. The procedures used in the field study were somewhat unconventional, in that a great deal of the information obtained required subjective value judgments on the part of the principal consultant. The procedure appears to be justifiable since no taxonomy exists for the kind of rigidly structured survey instruments that might normally be used. The controls rested with the panel of consultants who, in a sense, served as a jury of experts.

Personal interviews of individuals in 100 firms manufacturing or using photo-optics were made to determine the need for and the nature of curriculum content required for such a program at the junior-college level (Cooper, 1964).

Some studies combined the interview method with other data-gathering techniques. In a study to identify the task and knowledge clusters associated with the performance of major types of building trades work, both the interview and questionnaire were used (Bakamis and Others, 1966). In a study of the work of employees in the petrochemical industries (Reach, 1966), the normative survey technique was first used and than the personal interview was employed. An *ad hoc* committee appointed to study today's training requirements for agricultural and welding technicians at Yba College (Orum, 1965) selected an advisory committee. Later, survey forms were developed, interviewers were selected, and a pilot study was made. A study of office work (Perkins, Byrd, and Roley, 1968) used both the interview and questionnaire. The New York State Associate Degree Nursing Project (Kinsinger, 1964) used data from questionnaires, interviews, and college catalogs to

compare the curriculum emphasis of sixteen associate degree nursing programs.

Committees of Vocational Educators

Two studies in business and office education resulted in curriculum guides being developed by a committee of teachers at the local level (*The Pre-Technical Project, A Demonstration in Education for Technology, Business Technology, 11th Year,* 1967; and *The Pre-Technical Project, A Demonstration in Education for Technology, Business Technology, 12th Year,* 1967).

Teachers working with an advisory committee developed a guide for planning a curriculum for an associate degree technical education program in mechanical design technology at the post-high-school level (Gilsdorf and Others, 1965).

The Council on Dental Education of the American Dental Association used a group of deans and instructors of dental colleges, instructors of dental assistant training programs, practicing dentists, and dental assistants to develop a manual to serve as a guideline for program planning (*Organizing a Dental Assistant Training Program,* 1965).

Workshops of home economics teachers, teacher educators, and state supervisors developed guidelines for the curriculum for a new approach to teaching of home economics education (Pieretti, 1965).

A committee of teachers in trade and industrial education developed a workbook for students studying occupational analysis (*Study Guide D-2. Trade and Occupational Analysis,* 1968). This guide provides a step-by-step approach to the analysis process.

A guide for engineering technology was developed by a committee of teachers in New York City (*The Pre-Technical Project, A Demonstration in Education for Technology. Engineering Technology, 11th and 12th Year,* 1967). This guide was tested in the classrooms and later revised. The program emphasizes a team-teaching approach to interdisciplinary correlation of subject matter and a laboratory orientation of the curriculum.

Advisory Committees

Several studies emphasized the role of advisory or consulting committees in data collection for analysis of occupations for constructing of curriculums.

Recommendations of the Industrial Authentication Committee were emphasized in a curriculum guide developed in the Curriculum Laboratory of the Mississippi State Department of Industrial Education (*A Guide for Use in Developing Training Programs in Heavy Equipment Mechanics,* 1967).

A study supported by The Rosenberg Foundation of San Francisco (*The Richmond Plan,* 1963), illustrated the use of very active study committees. This study was of a program designed to meet the needs of the average high-school student by establishing a pre-technical curriculum in two high schools and in Cogswell Polytechnical College.

Suggestions for developing a data-processing curriculum are reported in a study growing out of a state-wide conference and later reviewed by local advisory groups (McKee, 1963).

The role of the advisory committee in occupation education at the junior-college level is presented in a publication by the American Association of Junior Colleges (Riendeau, 1957). Three types of advisory committees were discussed, with the functions of each relative to curriculum delineated.

The New York State Education Department (Cushman, 1965) developed a handbook to assist educational personnel in making the most effective use of agricultural advisory boards in the organization and development of local vocational agriculture programs.

Other Primary Sources

Innovative investigators have developed other methods of identifying content for the specialty of vocational and or technical curriculums. Further study of these methods should prove fruitful to individuals seeking to apply creative reasoning to data-gathering processes for analyzing the jobs of employees for occupational curriculum construction.

Job analysts prepared job descriptions after observing the output of the worker and asking questions about what he did, how and why he did it, and what skill was involved. This was part of a project, *Effects of Field and Job Oriented Technical Retraining on Manpower Utilization of the Unemployed,* as reported in a paper presented at the American Vocational Association Annual Convetion (Wiersteiner, 1968). The analysis technique used was one structured by the United States Bureau of Employment Security and used in the preparation of the 1965 Edition of the *Dictionary of Occupational Titles.*

A schema for classifying educational objectives in the psychomotor domain was developed as a result of the project, *The Classification of Educational Objectives, Psychomotor Domain* (Simpson, 1966). The general procedures included: a comprehensive review of literature, collection and analysis of behavioral objectives of the domain, laboratory analysis of tasks to discover psychomotor activity, and finally, conferences with scholars having specialized knowledge of the domain.

A modified version of the Q-Sort technique (card sort) was used to identify the common elements in the curriculum of six technical training programs (Schill and Arnold, 1965).

Fifteen certified secondary school counselors actually participated in an on-the-job investigation of three selected industries in Montana, namely, mining, lumbering, and construction, to secure personal knowledge of work involved for purpose of analysis (Corman, 1966). Each kept daily field diaries of observations, experiences, and conversations, and in addition, conducted case studies, where possible.

Synthesis, summarization, and interpretation of the studies completed by twenty-six states on agricultural occupations provided the basis for determining extensions and adjustments in curricular patterns in this field (Tay-

lor, 1966). This project represented a national effort to modify curricular offerings by determining the adjustments and extensions needed in high school and post-high school curricular patterns of vocational education in agriculture to more effectively provide preparatory training needs in off-farm agricultural occupations. Initially, a task force was used to conduct a nationwide search to identify capable personnel, visit and evaluate successful programs, and analyze and develop necessary materials. Later, a national advisory committee met to give direction to the development of the educational programs. This was followed by a national conference and area meetings to focus on responsibilities and activities and to determine needs for initiating programs at the local level.

Deriving curriculum from the study of pilot programs was used in agricultural education curriculum research in Illinois (Phipps, 1966). This resulted from recommendations of the committee for initiation of pilot projects (Phipps, Hemp, Warmbrod, and Fuller, 1965).

Secondary Sources

Often, curriculums are developed on the strength of analysis or research conducted by others. In this review, this is considered deriving curriculum content from secondary sources. Some studies using this approach are described in this section. In many cases authors of curriculum materials failed to indicate either sources or methods of arriving at content for the occupational specialty. As the methodology of analysis becomes better understood by more curriculum builders, it is hoped that not only will sources of content be identified by tests of validation but also, that performance goals will be established.

In a doctoral dissertation (Stern, 1964), data were secured by analysis of a textbook survey sent to administrative offices of 184 schools and colleges with programs in business administration or industrial engineering. The six most frequently used textbooks were selected for analysis in terms of agreeing with predetermined functions of industry. In addition, an opinionnaire was used to solicit reactions from professional management consultants specializing in the area of manufacturing.

A synthesis of entry requirements for office jobs for high school students was reviewed by fifty-three representatives from government, business, and industry participating in three conferences to discuss opportunities in office occupations (*Selected Entry Office Jobs for the High School Student, Report of Conferences with Government, Business and Industry*, 1965).

Descriptive focus of the content of the business curriculum is provided in relation to the general curriculum and certain fields of specialty in business in a helpful analysis by South-Western Publishing Company (Watson, 1966).

Secondary sources were effectively utilized in a guide for teachers of home economics (*Colorado Program Planning Guide for Home Economics Education—Secondary, Adult and Occupations*, 1967).

A committee of the American Society for Engineering Education produced from secondary sources a manual of educational standards for engineering technology education (McGraw, 1962).

A model of vertically integrated occupation curriculum was developed from secondary sources to stimulate the study of occupational education curriculums (*A Vertically Integrated Occupational Curriculum for Schools in Michigan*, 1968). The model deals with occupational curriculum from the elementary level through adult education.

Secondary sources were highly significant in development of a manual designed to assist in building curriculum in the Job Corps (*A and R Report Number 12*, 1968).

A summary of the state-of-the-arts in the development of training programs was produced by the Human Resources Research Office (Smith, 1966). In addition to summarizing the state-of-the-arts, it also provided general guidelines for the design of instructional systems. The approach is based on a survey of the available literature and draws particularly on HumRRO experience in research studies on training. The major sections of the report deal with the instructional system as a concept, the research evidence bearing on the major system functions, and methods for designing and evaluating the system in terms of cost and effectiveness.

Summary

The literature reflects the use in analysis of both primary and secondary sources. Primary sources use first-hand information gained from those actually doing the job, observing the job, interviewing the worker, or through such methods as mail questionnaires directed to the employee or other individuals of similar knowledge. Secondary sources use the findings of others through such documents as reports, textbooks, manuals, and periodicals.

Broad variation exists in the refinement applied by various individuals to data-gathering, data analysis, and translation of findings into curriculums. Some individuals, institutions, and vocational services have advanced the process of analysis to a much greater degree than others.

TYPES AND TECHNIQUES OF ANALYSIS

The literature, including the reports of research projects, supports the contention that there are two main types of occupational analysis for curriculum development: job analysis and task analysis. The ultimate purpose of both types is the same; the generation of occupational curriculums geared to the needs of students so that entry-level requirements of employment positions will be satisfied. The sources of information are the same for either type of analysis. The differences lie in the definition of the terms and the interpretation of the size of the unit used.

A number of techniques have been utilized in securing, analyzing, and converting the data into curriculum content. These variations are evident in the techniques used to identify the substantive content and the sources

of information selected. The occupational analyst is in many ways in a position similar to the historian. Some historians use, in the main, secondary sources and frequently make little effort to validate the sources used against the primary sources. This is also true of many who develop curriculums for occupational education programs. This reviewer found many techniques used to identify curricular content, often without any plans for validating the information. The variations of techniques range from extremely simple procedures to complex models of integrated systems involving massive research efforts. The techniques range from very crude tools of research to highly refined, integrated, and synchronized systems.

Occupational Analysis

Recently the term occupational analysis has become more frequently used in the literature of research. Job analysis and task analysis are, however, referred to much more frequently. While the techniques involved in occupational analysis are similar to those of job or task analysis, the scope of the research problem is much greater. Occupational analysis (Borow, 1964) has been described as the application of a systematic method of obtaining information focused on occupations and industries as well as on jobs, tasks, and positions. Occupational analysis focuses on occupations—duties, requirements, and environments. Four kinds of occupational information are secured and classified as follows:

1. Industrial classification. The Standard Industrial Classification has 79 major groups, 9 major divisions, and 1,500 industries.
2. Socioeconomic classifications. These classifications usually place the professional groups at the top with the laborers at the bottom.
3. Job content classification. *The Dictionary of Occupational Titles* or the Bureau of the Census classify groups of occupations together.
4. Worker characteristics classifications. There are two approaches used under this classification. The first is a measure of the characteristics of workers presently employed. The second is used to estimate from job information the characteristics required for the job.

The U.S. Employment Service has developed a system of worker traits analysis (*Selected Characteristics of Occupations by Worker Traits and Physical Strength,* 1968). Scales, such as the Minnesota Occupational Rating Scales, are available for estimating from job information the characteristics needed by the individuals seeking entry-level positions.

While curriculum materials may use all of the above classifications as related to occupational analysis, the current emphasis is still directed more toward job analysis or task analysis with the focus on a single or relatively small cluster of occupations or payroll jobs.

Job Analysis

Job analysis is the collection and interpretation of information about the work performed. It is an essential part in developing effective programs in vocational education or job training. Job analysis is needed to describe the

job toward which training is directed and to determine the effectiveness of training as reflected in job performance. The extensive use of job analysis for developing or revising training curriculums, establishing training standards or validating training course content is really just beginning (Morsh, 1963).

Any kind of work that is worthy and is complicated enough to make instruction necessary should be analyzed into its elements before attempting to teach it. This is especially true where quality instruction is desired (Fryklund, 1956).

The most frequent use of job analysis in curriculum development is to obtain information as the basis for decisions on content for the curriculum. Analysis is a technique of making an inventory of all the learning activities associated with a specific instructional area (Giachino and Gallington, 1967).

Allen identified the job as the basis of analysis; whereas, Selvidge considered the operation as the basis for analysis (Friese, 1958). Today, some follow the concept of Allen while others adhere to the thinking of Selvidge. Really the difference lies in the size of the basic unit into which the content is being divided. The operation is a basic element of a job or an action. It may be used singly or in combination with other operations to constitute a series of operations making up the work of an individual. An operation may be either mental or manual (*A Unit of Instruction, How to Organize It and How to Teach It*, 1962). The job is composed of two or more operations. The operation and the job both constitute the foundation for this kind of analysis. Each operation involves several steps which must be taught to a learner (Allen, 1919).

The operation is a unit of work in a job that involves making, servicing, or repairing. Operations involve such activities as depicting, forming, shaping, and assembling (Fryklund, 1956).

Two kinds of information are incorporated into the curriculum as a result of such analysis. These involve either doing (mental or manual) activities or knowing (related information) activities. The organization of the materials identified may vary. A common practice is to divide the occupation into large blocks and subdivide the blocks into units.

The services of the Armed Forces have contributed much to the literature of job analysis. A summary of the approaches used has been described by a group of researchers (Morsh, Madden, and Christal, 1961). As a result of an intensive research program during the last few years, the United States Air Force has developed and applied a novel procedure for collecting, organizing, analyzing, and reporting comprehensive job information (Morsh, 1964). Included in this approach is a hierarchial grouping computer program for treating identified data.

Perhaps the most spectacular analyses have been made in regard to space travel. A high degree of sophistication is used to determine the work to be performed by one or more astronauts and the specific order in which the work is to be done. Because of the physical stress involved, considerable attention must be given to the psychological factors in these analyses. Since

the information must be prepared before a flight, simulated conditions of flight are set up and studied prior to the actual performance. Subsequently, this forms the basis for training (Borow, 1964).

One of a series of publications by the U.S. Office of Education (Peterson, 1964b), indicates how job analysis and job relationship techniques can be used effectively in building training programs.

The use for analytical purposes of the personal interview coupled with the critical incident technique, the job analysis check list, and the personal data form are explained in a study entitled *A Study of the Critical Requirements for Directors in Educational Television Stations* (Adkins, 1967).

The job analysis approach has been utilized effectively in building may curriculum guides. Examples of these guides in various fields are: automotive mechanics (*Vocational Automotive Mechanics*, 1968; *Instructional Analysis of the Automotive Mechanic Occupation*, 1967); carpentry (*A Basic Plan for the Organization and Management of Instruction in Vocational Carpentry*, 1967); cosmetology (*Instructional Analysis of the Cosmetology Occupation*, 1968); tool and die (*A Basic Plan for the Organization and Management of Instruction in Vocational Tool and Die*, 1967).

The relationship of job analysis to job evaluation is established in a training manual by the U.S. Office of Industrial Resources (*Job Evaluation Operating Procedures*, 1960).

While job analysis has different meanings, applications, and implications, it is a fundamental step in determining curriculum content for vocational and technical education. In connection with such analysis much confusion has resulted in the use interchangeably of such terms as "job", "position", "task", and "duty". Review of a large number of studies indicates a great deal of overlapping in application of terms. In fact, it seems that it would be extremely helpful to simply identify these terms with the size of the increment of work performed on payroll jobs or positions. Later, these elements must be translated into essential, teachable content.

Task Analysis

An excellent job of characterizing task analysis has been done in a book entitled, *Guidelines for Training Situation Analysis* (Chenzoff, 1965). Task analysis is a method or a process by which a task is examined and its characteristics, in terms of certain attributes, are identified.

According to another author the task is the basic organizational and training unit for all activities at sub-managerial level (Welch, 1968). Another writer points out that task analysis has the objective of identifying the tasks invoved in the system being studied, and of obtaining whatever information is required about those tasks for completion of the training situation analysis (Folley, 1964b).

A task has been defined as the collection of activities that are: performed by one person, bounded by two events, directed toward achieving a single objective or output, and describable by means of the method set forth so that the resulting task description conveys enough information about the task to permit the necessary training decisions to be made (Chenzoff, 1965).

A task analysis determines the knowledge and skill requirements of the job. A systematic study of the behavioral requirements of the tasks is needed to determine the knowledge and skill content of each task (Butler, 1967).

The operation, the standard method for performing it and the technical information required, may be detailed precisely in a task breakdown. This becomes the basic instructional guide, with the operation as the basic instructional unit (Welch, 1968).

A task description is usually developed in three stages. First, the duties of each job are outlined; second, the tasks for each of the duties are listed; and third, the task analysis identifies standards of performance (Butler, 1967).

A task description is a list of job activities; whereas, a task analysis is the determination of the knowledge and skill requirements of the job. Therefore, basic to task analysis is the identification of the kinds of performance capabilities demanded by the tasks. Each task must be analyzed to determine the basis for all decisions. The selection of appropriate objectives, content, sequence, method, media, and evaluative criteria depends on the correct identification of the capabilities needed to perform the tasks (*Instructional Systems Development Manual*, 1968).

The Aerospace Medical Research Laboratories, in a recent publication, describes the development and evaluation of a Learner-Centered Instruction (LCI) program based on task analysis (Valverde, 1968). This report emphasizes that task analysis is a technique of analysis which can be a powerful tool in predicting job behaviors that can be converted to relevant training objectives. LCI criterion development consists of the preparation of job behavioral description and the development of the job-proficiency test. This is then followed by the development of the course and the evaluation of performance based on job-training standards. The sequence of steps in behavioral job analysis under the LCI approach is described as including the identification of tasks, the determining of the groupings of the task activities, and the describing of the behavioral details (Pieper, Folley, and Valverde, 1968). This study further explains the describing of behavioral details as consisting of: determining the procedure to be followed, continuous perceptual-motor activity, monitoring, communicating, and decision making and problem solving.

Task analysis is an essential step of the plan of analysis as developed and used by the Navy. This method is designated as the Systematic Approach to Multidimensional Occupational Analysis (SAMOA). A writer (Silverman, 1965a) describes the instruments for data gathering as consisting of a scale for rating the functional complexity of tasks involving the operation of equipment and machinery and a scale for rating the functional complexity of maintenance tasks. Each of the scales defines a series of levels of complexity in terms of the kinds of activities and processes involved. The bulletin contains illustrations of the task lists and other analysis forms. In another report (Carr and Silverman, 1966), the three major steps of the SAMOA system are described. The first step is the development and administration of comprehensive task lists and related data-gathering forms.

The second step is the computerized analysis of the data on tasks and task patterns. The third major step is a set of computerized procedures for stratifying and grouping clusters on the basis of significant variables within three fundamental dimensions of the work situation; namely, technical, organizational, and communicational.

Another study (Smith, 1965) compared the differences as well as the common elements of various approaches to task analysis. The study was concerned with the examination of the theoretical or empirical foundation and the determination of which features were included by some but excluded by others. Behavioral analysis and basic task taxonomy were two important parts of this research project.

Another research effort (Silverman, 1967) directed toward the recent developments in techniques of task analysis recommended that a task taxonomy be developed. Such a taxonomy would indicate the inherent similarities between tasks, independent of their environment, and pave the way for improvements in training. This study pointed out that problems of task classification can be approached more systematically through methods of numerical taxonomy than through traditional techniques. In recent years, human factor analysts and training psychologists have called for a taxonomy of tasks to provide a breakthrough in the state-of-the-art. They contend that, currently, techniques of task analysis require that every task be performed in a system or every job be treated as a unique entity or aspect of the work. As a result, task analysis, of even one job, can involve the study of an enormous number of tasks and their elements.

In training personnel, the development of a curriculum based on such complex and extended task analyses becomes rather difficult. As a result, it has been proposed that research be performed to systematically classify tasks in terms of criteria which include generalized variables, characteristics, and attributes inherent in the task without considering the task in a particular setting. This approach is built on the assumption that by classifying the behaviors required in performing a task and training personnel in the basic abilities implied by these behaviors, the curriculums may be made realistic in terms of task demands. Also, a task analysis based on selected categories or dimensions of task behavior provides a breakthrough by eliminating the necessity for repeatedly developing and analyzing long, detailed task lists or inventories. A set of such categories of task behavior has been called a taxonomy. A taxonomy involves the systematic differentiation, ordering, relating, and naming of type groups within a subject field.

Another investigator (Folley, 1964a) concluded that no set of suggestions or rules can reduce task analysis to a simple, routine job. He said that the description of human behavior is too complex and the number and variety of tasks are too great to permit reduction of task analysis to a simple routine. He did, however, in the book *Guidelines for Task Analysis* reduce and simplify to a degree the procedure in making task analysis.

Task analysis was identified as an important part of the planning of programs for the Job Corps (*A and R Report Number 12,* 1968). The approach was to divide the overall goals into small steps or milestones. An

approach to milestoning was the conducting of a task analysis of specific jobs.

A very helpful publication (Chenzoff, 1964) reviewed the literature on task-analysis methodology as it related to deriving training requirements.

Task analysis has been identified as the approach used in determining content for vocational and technical education in several studies and developed curriculum materials. A study (Drake, 1968) of the vocational training needs of persons entering employment in off-farm agricultural occupations in New York state employed the concepts of task analysis. The application of individual subtask-incremental time level was utilize in a recent study in the aviation field (*Development of Criteria and Methods for Evaluating Trainer Aircraft Effectiveness,* 1967). Development of a competency pattern for the job of the teacher-coordinator in distributive education was based on task analysis (Crawford, 1967). This study employed a variation of Q-methodology to determine the basic beliefs concerning all phases of the distributive education program. This was followed by in-depth group interviews and evaluation by selected distributive education teacher educators.

Several studies were reported in home economics. A team of home economists and day-care center employees and supervisors conceptualized and field tested a survey instrument to obtain up-to-date facts about major types and combinations of tasks performed by child-care workers (Rahmlow and Cavanagh, 1966). A ranking of major tasks in non-professional child-care occupations was contained in another report (Rahmlow and Kiehn, 1967). Two studies in food service were made at the University of Missouri. In one of these (Welch, 1966), the industrial-training procedures were compared with the procedures of the food-service industries using a task analysis approach. The questions of what, why, how, when, who, and where were obvious in the study. In the research project, *A Task Unit Concept for On-The-Job Training in Food Service* (Welch, 1968), the steps essential to task analysis were documented. These included identification, description, analysis, and development of the training program.

The functional applications of task analysis are outlined in a Florida State Department of Education bulletin (*Guidelines for the Training of Nurse Aides,* 1968). Emphasis is placed on organizing the tasks into a purposeful sequence or pattern in accordance with sound educational concepts to develop the course of study.

A variety of techniques and procedures has been used in the research reviewed. While considerable variation exists, common procedures include identification, inventory, classification, and, in some cases, validation. Several different models have been developed and reflected in this review.

Identification of Content

Basic to the total process of analysis is the identification of content. Without accurate identification of content, analysis is meaningless. Often, increased attention needs to be given to identifying of current practices, methods, skills, and knowledges which apply to the job. A number of various

approaches may be used to identify content. The completeness and importance of identifying substantive content is a significant element in the validity of analysis, and, consequently, of the total educational program.

As the result of an intensive research program during the past few years the United States Air Force has developed and applied an improved method of collecting, organizing, analyzing, and reporting comprehensive job information. The procedure combines features of the check-list method with those of the open-ended questionnaire and the observation interview into a single integrated procedure (Morsh, 1964).

Identification of behaviors common to a number of occupations was the intent of a well-designed study in this field (Sjogren, 1967). This study used an instrument specifically developed for the purpose. The instrument was pilot tested in thirty interviews, revised, and tested again with another group of thirty interviews. The reliability, determined on the basis of correlations, assured the researchers that the instrument was ready for the main data-gathering effort of the project. The data of the project were collected by interviewing job incumbents.

Occupational fields have not defined adequately the human tasks required in their particular field according to another investigator (Martin, 1965).

Identification of worker-oriented job variables was the purpose of a significant study by two psychologists (Gordon and McCormick, 1963). A worker-oriented variable is defined as one which describes an activity in terms of what actions the worker is performing without reference to the job or product involved. The first stage of the study dealt with the development of an appropriate format to measure worker-oriented variables. These variables were developed from a review of the literature and then translated into check-list items. An initial reliability study was conducted with the check list (which was then titled *The Worker Activity Profile)* and items were revised, where needed. The final application of *The Worker Activity Profile* was made with a sample of 400 jobs representative of the percentages of jobs in the major occupational areas of *The Dictionary of Occupational Titles.* A reliability analysis was also conducted with a subsample of 100 jobs.

Many studies reflect the more traditional approach to the identification of content. An extensive study (Allen and Others, 1968), focused on identifying the duties and responsibilities for each rank within the fireman's occupation. Another study (Ertel, 1966) sought to identify the major tasks performed in retailing occupations. A national survey was undertaken to investigate the technical knowledge and manipulative skills of aviation mechanics, as required by the aviation industry, to identify the core curriculum for training aviation mechanics, and to identify the scope of training offered by the industry (Allen and Others, 1966).

Identification of current practices, as reported by former students, was the approach taken in a large-scale study of the former students of approximately forty selected institutions (Armstrong and Witney, 1966). The instrument for this follow-up study was carefully tested prior to use.

The primary purpose of a study involving management (*A Study of Recommendations for Technical Education Curricula*, 1965) was to have management personnel and technicians identify cores of subject matter related to technician job performance and to differentiate between their judgments. A ninety-nine curriculum deck, representing most subject matter areas considered of possible value as preparation for any one of the various technical occupations, was used to identify related, somewhat related, or unrelated activities. Interviews provided data on the age of respondent, educational background, job history, manufacturing classification of the employing firm, and management-technician working relationship.

The functions approach was used to determine content for a training program for agricultural business and industry (Clark, and Meaders, 1968). The functions approach was suggested as a framework for identifying of curriculum content some years ago at Michigan State University. The approach was geared to identifying the functions of the industry such as processing, transporting, purchasing, selling, and accounting. Next, the activities necessary to accomplish the functions were determined. These, in turn, were used as a basis for identifying the competencies needed by the individuals who are expected to perform the activities.

Identification of curriculum content needing modification was one of the goals of a study of the educational and occupational experiences of graduates from the Pocatello and Idaho Falls high schools over a ten-year period (Fifield and Watson, 1967).

The procedure for curriculum development in technical education having as the initial step the identification of content of the occupation, is contained in a series of guides developed with the support of the U.S. Office of Education. Representative guides of this series are identified with chemical and metallurgical technologies (Peterson, 1962a), electronic data processing (Peterson, 1963), civil and highway technology (Peterson, 1964a), electrical and electronics technology (Peterson, 1964b), and mechanical technology (Peterson, 1962b).

Another U.S. Office of Education publication, typical of another sponsored series in many technical fields, provides assistance for determining content in courses of study in vocational education (*Mechanical Drafting and Design Technology*, 1964).

The hypotheses that major tasks performed by food-service workers required clusters of similar knowledges and competencies were supported in a recent survey which identified clusters of knowledges and competencies in this field (Rahmlow, 1967).

The job-requirement list was used by Abbott Laboratories (Rantala, 1961) in the appraisal of training need analysis. The assumption was made that every trade or industrial occupation has certain broad principal areas of knowledge, skill and/or work assignment. These constituted the basis for the content of the job-requirement list. This list can be used to identify processes, work responsibility, skill, and knowledge as well as other related information. The method of developing the job-requirements list is only a means to create a system or framework for the trade analysis. The important

consideration is that the items of the job-requirement list lend themselves to subdivision into the items of skill and knowledge. The training need analysis lists all skills and knowledge required of a competent worker performing in the areas listed.

A Worker Activity Profile (McCormick, 1964) is another way of identifying job tasks performed. The purpose of the profile is also to provide a continuum to indicate the degree of individual involvement with the items listed on the profile. The *Worker Activity Profile* was used to establish synthetic validity of predictors of job success, for job evaluation, and for operational job analysis to establish job requirements.

Inventory

A few studies alluded to the procedure of building an inventory of identified skills and knowledges needed in the occupation. In a study at Lackland Air Force Base the revised method of job analysis, including research, centered around the use of the task inventory (Morsh, Madden and Christal, 1961). Considerable attention was given to internal consistency and test-retest reliability. This study cited the experiences of several other investigators on measures of reliability. A later study by the same research (Morsh, 1965) resulted in improvements in inventory content and format and also in refined administrative procedures for each successive survey. In this study, a computerized hierarchical grouping procedure was applied to the time-spect data to identify and describe job types.

Another study which demonstrated in detail using miniature examples began with a small-job inventory (Archer, 1966).

In the *Procedural Guide for Conducting Occupational Surveys in the United States Air Force* (Morsh and Archer, 1967) various types of job inventories are mentioned. References are made to an officer-job inventory, and airman-job inventory, and similar groups.

The task inventory is described in detail in a publication, *Courses Design and Redesign Manual for Job Training Courses* (Rundquist, 1967) by the U.S. Navy. This manual identifies the task inventory as a list of tasks performed on-the-job or duty assignment toward which the training is directed. Those tasks are often referred to as behaviors because they become the behavioral elements of the end-of-course objectives. The critical points in developing a task inventory are the task statements which must be accurate, complete, unambiguous, and nonoverlapping.

The inventory is referred to in another publication (Morsh, Madden and Christal, 1961) of the United States Air Force. In describing this approach, reference is also made to the methods of the other Armed Forces. The Air Force method uses the group-interview and the technical-conference methods merged into a single integrated procedure. Using information derived from job descriptions, job training standards, and other available sources, a personnel officer or his designated assistant constructs a preliminary duty and task inventory according to a standardized format. At least two technical advisors assist in this initial construction in order to make the inventory as complete as possible and to insure proper technical terminology. The ten-

tative inventory is then sent out to five or more Air Force bases. Here technical advisors carefully review the inventory making deletions or additions to duty or task statements. The annotated inventories are then returned studied, and used as the basis for the development of the final form for the full-scale survey. The revised task inventory is then reproduced and sent to selected bases, where it is completed and later returned for analysis. Determination of both reliability and validity is included in validating the instrument.

Many studies use an inventory technique without referring to it as such. The construction of a taxonomy in a vocational field represents a different kind of inventory concept. Good illustrations of this approach are found in *The Classification of Educational Objectives, Psychomotor Domain* (Simpson, 1966) and A Taxonomy of Office Activities for Business and Office Education (Huffman, 1968).

Classification

A few investigators have discussed the problems of classifying their research findings. In a paper dealing with manpower projections of scarcity, quality, and obsolescence (Martin, 1963), a comparison of three approaches to occupational classification was made. The first approach involved was the critical-incident technique. In this method, the collection of on-the-job specifics of behavior were classified as effective or ineffective performance in assumed main areas. An effort was made to determine how these were different from others in the same group. The functional job analysis method classified as worker functions the collection of on-the-job specifics of behavior. The purpose was to answer the question: "What does the worker do that differentiates his activities from others in other groups?" A third method of classification was the functional criterion analysis approach. In this method the collection of on-the-job behavior specifics were classified in terms of worker functions and content areas. This attempted to answer the questions: "What does the worker do that differentiates his activities from others in other groups? What kinds of knowledges are different?"

In other paper, the same author (Martin, 1965a) explained the use of the methods of job classification in a study of personnel in the field of instructional media. In the research report (Martin, 1965b) an explanation is given of the combination of the combination of the techniques of Functional Job Analysis, hereinafter referred to as FJA, and Critical Incident Technique, identified hereafter as CIT, quantitative indicators for grouping media jobs into four major areas and qualitative dimensions for classifying educational implications of the different performance categories derived. A computer-based mulitvariate statical analyzer system was adapted for finding the relevant occupational groups and relevant variables. Additional insight on factor analysis of items of job satisfaction using the FJA approach is provide in another publication (Martin, 1965c).

The description of a statistical technique (Silverman, 1965b) devised to classify work-tasks by their level of complexity is contained in a bulletin by the United States Naval Personnel Research Activity. Although this report

is intended primarily for personnel conducting research in the area of occupational and organizational analysis, it may be of interest to those concerned with the general problems associated with job-task identification and classification. The main concept applied in the research is that of Systematic Approach to Multidimensional Occupational Analysis (SAMOA).

The Functional Job Analysis method is explained in a *Manual for Supervisors and Performance Appraisal Instrument* (Fine, 1961). Its performance-appraisal instrument providing rating scales for things, data, people and core (adaptive) behavior is applicable to a wide range of occupations as demonstrated by the author. The same author in an unpublished doctoral dissertation (Fine, 1962) explained the use of the FJA system to estimate the amount of nine aptitudes required for average successful performance in each of eighty-five jobs and to predict the three, four, or five aptitudes that would be significant for selection. The study provides evidence of the usefulness of the Functional Job Analysis rationale as a means for arriving at synthetic validity, that is, predicting empirical validities.

The findings of an interesting study (Levin and Martin, 1963) indicated that the criteria useful for the functional classification of occupations could be obtained through the clustering of FJA variables on the ability to maximally spread job incumbents. The multidimensional performance space obtained by these techniques provides a way of viewing the changes taking place in jobs.

A study (Fine, 1963a) demonstrated the use of FJA technique in conjunction with Critical Incident Technique, Behavioral Styles Self Report, and Satisfaction Questionnaire in developing comprehensive information about jobs and incumbents for curriculum purposes. The FJA and Behavioral Styles Self Reports provide the analytical dimensions of jobs and workers pertinent to each other. The Critical Incident Technique and Satisfaction Questionnaire provide dynamic interpretation of information of worker to overall job demands and information for a performance criterion. With this information as a base, the content for development of training programs is expedited.

The intermeshing of human capabilities with system performance requirements is discussed in another paper (Fine, 1965b). It illustrates the use of worker functions as a basis for research and suggests a conceptual model for a functional approach to a behavioral and task taxonomy applied to manifest skills.

FJA was used as a means for measuring change in educational and training requirements for jobs experiencing the impact of automation (Fine, 1964a). Varying functional patterns were equated with varying educational and training levels and validated by on-the-spot interviews with management and workers in three industries. The investigator (Fine, 1964b) described the impact of three types of automated equipment upon human mental and physical requirements.

FJA was used to measure differential impact on job structure by the

introduction of automated equipment in two production and one office situation (Fine, 1965a).

Individuals seeking more information on the Functional Job Analysis approach will find an annotated bibliography (Fine, 1965b) helpful. FJA is an outgrowth of occupational classification research conducted by the United States Employment Service, Occupational Analysis Division, 1950-1960, under the general direction of Carl J. Heins, Chief of the Division, and Sidney A. Fine, Director of Research.

The roots of Functional Job Analysis extend back to the work carried out under the direction of William Stead and Carroll Shartle in the United States Employment Service, starting in 1935.

One of the central classification ideas of Functional Job Analysis is THINGS, DATA, AND PEOPLE, as fundamentals in organizing and expressing what gets done in jobs and what people bring to them in the way of capacities and potentialities to get the job done. While this concept is original in FJA, the British had earlier used these same ideas for vocational counseling. This same idea was quite thoroughly developed more than a generation ago by John Mills, Western Electric Company, Incorporated, New York.

While the FJA technique is still in its infancy, it has several useful applications including the analysis of jobs for job design, job evaluation, curriculum development, and performance criteria.

Models

Models of great variety have been developed for analyzing of occupations to derive content for curriculums.

A typical model for the community survey to compile performance specifications for multioccupational classifications is contained in the report from California given at a leadership seminar (*National Association of State Directors of Vocational Education*, 1968). In another common model (Perkins and Byrd, 1966) identification and correlation of major tasks of office workers with major requirements of the job were established. A simple model for determining the vocational education needs of a community and the analysis of data into curriculum is available from the Nebraska Research Coordinating Unit (Cromer, 1968).

The Position Analysis Questionnaire (PAQ) constitutes a model for characterizing various aspects of positions (*Position Analysis Questionnaires*, 1967; Mecham, 1969). This consists of a listing of elements each of which is descriptive of, infers, or implies some human behavior or activity, or some aspect of the work situation that impinges upon the worker. The major divisions of the Position Analysis Questionnaire are information input, mediation processes, work output, interpersonal activities, and work situation and job content.

The jury of experts approach is illustrated by an excellent study to identify task and knowledge clusters associated with office employee's work (Perkins and Byrd, 1967). This method was also used in a study to determine the competencies essential for feed-industry sales personnel (Albracht, 1966).

The Worker Activity Profile which is a model built upon the use of the check list is illustrated by a study at Purdue University (Gordon, and McCormich, 1963). This study was an attempt to identify, measure, and explore the dimensions of worker-oriented job variables. Another application of *The Worker Activity Profile* was made with a sample of 400 jobs representative of the percentages of jobs in the major occupational areas of *The Dictionary of Occupational Titles*. The factor analyses of 119 items resulted in seven designated factors: varied intellectual vs physical activities, decision making and communications activities, skilled physical activities, hierarchical person-to-person interaction, man-machine control activities, unnamed, and pleasant vs unpleasant working conditions.

Role analysis constitutes another model (Todd and Woodin, 1966). Data collected from twenty-five beginning teachers and their administrators identified for beginning and experienced teachers differences between role perceptions and professional difficulties. This approach may be used to select content for curriculum development in vocational education.

Two studies used the textbook survey as a means of determining the acceptability of the functions of industry for a curriculum framework for industrial education (Stern, 1964; Jelden, 1960).

Development and utilization of an experimental curriculum contribute positively to the variety of significant models for curriculum building. Description of the experimental curriculum for the New Quincy, Massachusetts, vocational-technical school is contained in several reports (Morrison, 1965a; Morrison, 1965b; Morrison, 1965c).

The taxonomy as a model for analysis is reported in research studies (Huffman, 1968; Simpson, 1966, and Martin, 1966) which should be very helpful to individuals seeking information on this method. The *Taxonomy of Office Activities for Business and Office Education* provides an orderly and systematic way of looking at office activities in the operating, interacting, and managing dimensions. This taxonomy beings with a review of secondary sources and resulting collection of data; and continues with revision of the data and testing. Several juries reviewed the taxonomy. The result of the study is a list of approximately 800 action verbs organized in three domains: operating, interacting, and managing, each of which has primary and secondary divisions. *The Classification of Educational Objectives, Psychomotor Domain* is a schema for classifying educational objectives in the psychomotor domain resulting from the collection and analysis, and conference with scholars of the domain. Another research project was designed to develop a taxonomy for classifying vocational education objectives (Yagi, 1968). This study had as additional objectives the providing of a framework for evaluating and comparing existing programs and establishing criteria for the design and development of a radically different comprehensive curriculum. It reported that the taxonomy was first used with objectives from an existing vocational-technical education program. It was tested through interjudge agreement in the categorization of a large sample of prepared objectives and was then used on existing high-school curriculums. A macrotechnological analysis (DeVore, 1966) developed as a means of defining a taxonomy is helpful in curriculum planning.

Snap maps as a model of analysis for determining occupational curriculum content were explored in a study *The "Orchestrated System" to Industrial Education* (Yoho, 1967). This model, designed by Systems Network Analysis Process, used simplified flow charts to expose tentative social and industrial elements of the curriculum. A somewhat similar approach was found in another study (Moss, Smith, and Pucel, (1968). The methodology consisted of producing maps of the technical concepts possessed by selected workers. These maps represented the cognitive goals of instruction and provided the clues for curriculum development. Two studies conducted by the Minnesota Research Coordination Unit were designed to develop and test the free association methodology. The associative methodology, according to the investigators, seemed capable of empirically and reliably generating a conceptual map of a given occupation which appeared to have face validity for experts in that occupation. It seemed to be sensitive enough to differentiate between workmen performing the same tasks at different qualitative levels.

The Q-sort (card sort) technique was used in two studies. In one, the role of mathematics in electrical-electronic technology was studied (Barlow and Schill, 1962). In another, (Schill and Arnold, 1965) a modified version of the Q-sort technique was used to identify the common elements in the curriculum of six technical training programs. In this study, each card contained a brief description of a course, developed to approximate the course content of most technical institutes. The validity of the cards was assessed by a panel of experts and a series of three pilot studies to assure understandability and coverage of the area. The individuals were asked to respond to a set of cards. The data were collected through interviews. Analysis of data included the use of analysis of variance, contingency coefficient, and chi-square. The study resulted in the identification of the core program with specific knowledges for each of the six technologies: electronic, electro-mechanical, mechanical, chemical-mechanical, chemical, and electro-chemical. The core program and the specific programs of the six technologies embraced a total of thirty-seven card-sord-sort items which could be conceived as course descriptions.

A model, eventual analysis, was used to study paramedical occupations as a foundation for development of curriculum (Decker, 1967). Eventual analysis consisted of making all key statements reducible to philosophical fundamentals, that is, to statements of childlike simplicity about real objects and real events. Since experience is the distinguishing characteristic of the trained medical laboratory assistant, as compared to the novice, eventual specifications of the primary components of the quality experience were narrowed to a list of errors and how to avoid them. For each laboratory procedure studied, this technique was employed. The key question in this form of analysis was, "Specifically what must I see a___do in order that I would say he is___? For example: How does a *laboratory assistant* differ from a *laymen*, that is, what must I see a person do in order that I would say he is a laboratory assistant and not a laymen?"

A model using the concept of set inclusion was the basis for the research

in another study (Mosel, 1963) of a random sample of 500 jobs from the *Dictionary of Occupational Titles* with respect to twenty-seven worker functions. Set inclusion implies that within certain limits, the set of jobs is characterized by another worker function. Methods for analyzing the matrix of worker-function overlaps and inclusions were developed. Results showed that twenty of the twenty-seven worker functions formed a complex partially-ordered set which could be displayed as a graph-theoretical tree with four levels. Thus, to a large extent, the domain of worker functions (and hence the domain of jobs) forms a topological hierarchy in which each worker function either includes or is included within some other worker function.

A model for charting the relationships of occupational cores to fields and also to branches is presented in the form of a zoned analysis technique (*A Unit of Instruction, How to Organize It and How to Teach It,* 1962). This publication explains the use of other charting techniques as the content analysis chart and develops the process of building curriculum materials such as operation sheets and related-information sheets. In a mimeograph release from a state research coordinating unit (*Zoned Analysis Techniques in Planning and Curriculum Development,* 1968) the zoned-analysis approach is defined and illustrated.

A model for developing and testing an evaluation plan for vocational education (Tuckman, 1967) has some implications for curriculum building. The technique is based upon a model which translates the learning processes and objectives into easily identifiable behavioral responses. After behavioral goals have been translated, they can be analyzed into a sequence of prerequisite behaviors by task analysis. This sequence of requisite behaviors is then used as a frame of reference for the development of content validity test items.

Summary

Clear definitions of the terms used in analysis are difficult to find in the literature. Positive distinctions between and among the characteristics of the various systems of analysis are even more difficult to establish. Much overlapping was evident between the definitions and techniques of job analysis and task analysis. The alert student of analysis finds identifying characteristics helpful in making distinctions between the types of analysis and the meanings applied to each of the main terms used in each process. The literature reviewed in this section provides such a basis, as well as to review both the philosophy of analysis and the methodology used.

TRANSLATING CONTENT INTO COURSES OF STUDY

The process of translating the fruits of analysis into curriculum and also into courses of study follows the analysis of the occupation. This section is devoted to the step between the analysis process and the building of the course of study.

A series of publications has been developed in the trades by national committees appointed by the Department of Labour of the Candian government to make analysis in specific fields.

This massive effort was the result of the recommendation of the first National conference on Apprenticeship in Trades and Industries in 1952. The Federal Government was requested to co-operate with Provincial apprenticeship committees and others in preparing analyses of a number of skilled occupations.

It was decided that the analysis would set forth only those phases of the trade that were condisered essential in each and every province. The result was the compilation of information helpful in the building of courses of study, but these documents are not courses of study.

A similar procedure was followed in each case. A national committee was appointed by the Department of Labour. Each member of the committee prepared a part of the analysis. Each part was submitted to the other members of the committees for critical review. Upon completion of the whole analysis, proof-copies were prepared and distributed broadly across Canada for general criticism. All suggestions were considered and then the final publication was produced.

The analyses are recommended as guides to foremen and others who do training on the job as a basis for development of programs in industry and for courses of study in vocational schools, trade institutes, and similar educational centers; as a yard stick by which previous experience may be evaluated; and, finally, as a means of transferring apprenticeship credits from province to province.

The approach used is to divide the trade into major divisions or blocks. Each block is then subdivided into units. For each unit, the operations and related knowledge are determined and listed.

The books of this series provide a wealth of analyzed information for curriculum builders. Two trades, sheetmetal (*An Analysis of the Sheet Metal Trade,* 1958) and auto body repair (*An Analysis of the Motor Vehicle Repair Trade—Body Division,* 1958) were analyzed during the late 1950's. During 1960-1965, several other trades were analyzed: commercial cooking (*An Analysis of the Cooking Trade,* 1961); oil burner servicing (*An Analysis of Residential Oil Burner Installation and Servicing,* 1962); refrigeration and air conditioning (*An Analysis of the Refrigeration and Air Conditioning Trade,* 1963); painting and decorating (*An Analysis of the Painting and Decorating Trade,* 1963); and toolmaking (*An Analysis of the Toolmaking Trade,* 1963).

Since 1965, the following trades were analyzed: millwright (*An Analysis of the Industrial Mechanical Trade, Millwright,* 1964); auto mechanics (*An Analysis of the Motor Vehicle Repair Trade-Mechanical,* 1964); electrical (*An Analysis of the Industrial Electrical Trade,* 1964); instrumentation (*An Analysis of the Industrial Instrumentation Trade,* 1965); and warm air heating and air conditioning (*An Analysis of Warm Air Heating and Air Conditioning Installation and Servicing,* 1965).

BUILDING CURRICULUM FROM ANALYSIS

An Overview

Reports of research findings and other literature reviewed provided some background information for building curriculum. Some studies concentrated on such elements of curriculum as objectives, individual learning programs, the cluster concept of curriculum, computer-assisted instruction, programmed instruction, and evaluation. Much reinforcement and considerable overlapping were found. Other topics were not dealt with, resulting in definite voids.

Building curriculum and constructing courses of study are discussed relative to vocational and technical education in several books (Giachino and Gallington, 1967; Mager and Beach, 1967; *A Unit of Instruction, How to Organize It and How to Teach It,* 1962; Fryklund, 1956; and, Bollinger and Weaver, 1955). Giachino and Gallington discuss the various types of curriculums as correlated curriculum, traditional subject-matter curriculum, fused curriculum, broad-fields curriculum, and core curriculum.

Bollinger and Weaver outline a complete plan of analysis and establish the ultimate objective as the formulation of a master course of instruction based on well-known techniques used in building corses of study.

Fryklund provides a detailed approach to analysis techniques for instructors of vocational and technical education with the main emphasis on trade analysis. He then introduces the process of course development, including the writing of operation sheets, information sheets, assignment sheets, and job sheets.

A Unit of Instruction, How to Organize It and How to Teach It provides a framework for zoned analysis and content analysis using as the vehicle of instruction the operation sheet and the information sheet.

Mager and Beach provide an excellent method for developing the course of study after the content for it has been determined. This is followed by a plan for field testing and refining to insure validity.

The Preparation of Occupational Instructors (Cochrum, 1966) and *Technician Training Beyond the High School* (Emerson, 1962) contained much helpful information relative to construction of courses of study. Cochrum treats teaching; learning evaluation; testing; and organization and management by means of lesson plans, instructor's guide sheets, handout sheets, and sample sheets. Emerson discusses the process of the development of the curriculum and the courses of study with illustrations of several possible techniques that may be used.

Two handbooks issued by State Boards for Vocational Education were designed to meet the needs of specific subject matter teachers. One (*Colorado Program Planning Guide for Home Economics Education—Secondary, Adult and Occupations,* 1967) was written to serve the needs of teachers in home economics. This publication explains in detail the basic elements of curriculum dealing with such topics as objectives, content, learning experiences, and evaluation. It then provides models, flow charts, and suggestions for planning curriculums for home economics. The second (*Hand-*

book for Research and Planning for Vocational, Technical and Adult Education in Wisconsin, 1968) explains the cycle of curriculum building. Topics include: behavior analysis, development of course and topic objectives, selection and development of instructional materials and methods, creating learning environments, and measuring outcomes.

The National Education Association has published a series of helpful papers relative to curriculums (*Innovations in Planning School Curricula—Appendices,* 1964).

The central problem of curriculum development and instructional innovation is identified and analyzed in a research project conducted in a rigorous search for a conceptual system (Goodlad, 1966a). The investigator concluded that the ultimate starting point in curriculum development for a specific objective must be a set of values. Flow charts for developing curriculums for these values were provided, representing a preliminary conceptual system. In another study, the same researcher (Goodlad, 1966b) relates educational objectives, curriculum organization and evaluation, and instruction to the changing school curriculum in elementary and secondary schools.

A study designed to generate a rational approach and a design for planning a conceptual basis for developing common curriculum in vocational teacher education provided an interesting model (Courtney, 1968).

A guide for developing certain types of preparatory programs in technical education incorporates patterns of curriculums with suggestions for development (Roney, 1962). The same author in his doctoral dissertation (Roney, 1964) analyzes the mathematics and science content of Engineering Council for Professional Development accredited curricula in various categories of post-high school technician training institutions across the United States. This study contains several helpful suggestions for curriculum building.

The Oregon Division of Community Colleges and Vocational Education has developed two curriculum guides in vocational education. The steps in the organization of a program are identified in one of these (*Guide for Organization and Administration of Vocational Education Programs in Secondary Schools,* 1966) as including: determine occupational objectives, organize advisory committee, determine employment opportunities, analyze occupations for knowledges and skills required for competency, and establish evaluation procedures. A later guide (*Guide to Structure and Articulation of Occupational Education Programs,* 1968) provides a conceptual frame work for a dramatic expansion and improvement of occupational education and a flexible guideline to help translate the conception into operational reality. Approaches, procedures, and content are included in the guide.

There are several program guidelines in the field of agriculture which provide aids and patterns for translating the results of analysis into courses of study. Three such guides were especially good (Hull, 1966; Bice, 1967; and McDonough, 1967).

Curriculum builders in business and office education may wish to review

curriculum guides in this service. Two guides are available from the U.S. Superintendent of Documents (Leslie, 1967; and *Stenographic, Secretarial and Related Occupations, A Suggested Curricula Guide,* 1967). Another is available from the California State Department of Education (Aiking, 1966).

The Division of Vocational, Technical, and Adult Education in Florida has two recently-developed guides for curriculum building in technical education (*Guidelines for Establishing and Evaluating Civil Engineering Technology Programs,* 1967; and, *Guidelines for Establishing and Evaluating Drafting and Design Technology Programs,* 1968).

Three publications that use analysis were reviewed in health occupations. One of these focused on the common courses in paramedical education (Fullerton, 1966); another report concentrated on job analysis of the surgical technician, practical nurse, and nurse aide in relation to curriculum (*Pittsburgh Technical Health Training Institute Demonstration Project,* 1967). A third was a conference report on a number of factors needing assessment (*A Plan to Grow by for Practical Nursing Education Programs,* 1968).

Several publications were reviewed with special implications for curriculum building in diverse areas. One reported research to evaluate new training materials in teaching basic vocational talent skills to 8th and 9th grade students (Dailey and Neyman, 1967). Another reported on curriculum development in the experimental curriculum of the New Quincy, Massachusetts Vocational-Technical School (Gagne, 1965). Bridging the gap between vocational and technical education and general education was the topic of a study (*Adapting Educational Change to Manpower Needs in Quincy, Massachusetts, and Wood County (Parkersburg), West Virginia,* 1966) which included planning for change, in-service education, curriculum revision, and instructional flexibility.

An analysis approach to the collegiate curriculum was suggested in a study (Mayhew, 1966) which criticizes major existing thoughts about collegiate curriculums and suggests how some of the curriculum problems might be solved. This study has implications for vocational and technical curricula at the collegiate level.

A paper (Morrison, 1969) discussed trends in curriculum development in vocational education. It placed emphasis on the need for curriculums that are more responsive to the requirements of the job market, to the needs and interest of students, and on more vocational flexibility.

Two studies were concerned with the center concept related to curriculum development. One study explored the feasibility of establishing an educational resource center (Hill, 1965), while another (Larson, 1965) developed a model for a vocational-technical teacher technology center.

Objectives

Several studies related to the determination or application of training objectives. A training objective (Smith, 1964) is a precise clear statement of one of the performances expected of a student upon completion of a course. The development of job-related, detailed statements of objectives is a matter of the first importance in designing effective training programs. These ob-

jectives permit every other element of the vocational education program to fall into line.

The book, *Preparing Instruction Objectives* (Mager, 1962) clearly explains and illustrates how to write objectives in terms of behavioral changes. Mager says that objectives should be expressed in terms of the expected outcomes describing what the learner will be doing when applying the skills and knowledges acquired. Well stated objectives use specific statements rather than general concepts and identify in the objective the criterion of acceptable performance.

The translation of the job specification into training objectives as the second requirement for building an effective technical training program was presented in a paper to the National Society of Programmed Instruction (Morsh, 1963).

Research reports (Morrison, 1965a; Morrison, 1965b; Morrison and Gagne, 1965) of the *Development and Evaluation of an Experimental Curriculum for the New Quincy (Massachusetts) Vocational-Technical School* place much emphasis on the translation of the analysis into behavioral objectives.

In order to accomplish the writing of terminal performance objectives (Nuckols, Tingley, and Lee, 1968) it was necessary to determine the curriculum which would be included, the proper order in which the curriculum should be dealt with, and the level of the instructional program.

The objectives of training (Eckstrand, 1964) must be based upon specific knowledges and skills which are required in job performance standards. These, in turn, are based upon the tasks identified and analyzed which constitute the payroll job.

Course objectives (*Manual for Course Planning at Western Piedmont Community College,* 1966), according to this manual, should be stated in both a teacher-oriented and student-oriented form. The teacher's document will identify the work to be done by professional and nonstudent personnel involved in the learning process. The student's document is to identify at least the minimal work program of the student.

A document from George Washington University identifies a six-step process for defining job-relevant objectives for training military personnel (*The Development of Training Objectives,* 1965). These six-steps apply to delineating objectives for all vocational programs. These steps include: system analysis, task inventory, determination of what tasks to teach and at what level, task description, task identification and relation to other elements, and, finally, expressing the task in the form of a training objective. The objective, the author states, should include performance expected of the student and the conditions under which the performance will be observed or measured, as well as a standard of accuracy.

The matter of objectives and the expected end results of training were basic to all discussions at a recent conference on "The Relationship of Automatic Data Processing Training Curriculum and Methodology in the Federal Government" (Sullivan, 1968). It was decided that a desirable approach was to determine the total body of knowledge required by an analyst

and then by means of a diagnostic process select the modules or elements of the total curriculum necessary for individuals who require varying degrees of competencies.

The relationship of individualized instruction and curriculum development was emphasized in three research reports studied. The primary objective of one of these studies (Finch, 1969) was to develop an instrument which would accurately measure student attitude toward individualized shop and laboratory instruction. As a basis for instrument development, a psychological objective was specified as a student attitude toward practical individualized shop and laboratory instruction. Statements which related to the objective were then constructed. An initial evaluation of the statements was performed by a jury of five persons with fifty statements selected for the final decision of the jury. This was later field tested with students in five vocational classes.

Self-pacing programmed instruction books were designed to help students independently acquire mathematics capabilities associated with work in building trades, office, retailing, electronics, food service, child care, and agricultural occupations in a recent study at Washington State University (Rahmlow, 1968).

The individualizing of instruction through the use of the computer was tested in a project at the Boulder Valley Public Schools (*A Computerized Approach to the Individualizing of Instructional Experience.)*

Cluster Concept

Washington State University has concentrated several research projects on the identification of major clusters in various vocational fields and the development of curriculum using this concept. The objectives of one of these studies (Ertel, 1968) was to identify major clusters of tasks performed by merchandising employees working in three Standard Industrial Classifications.

In another study of this series, the objective was to obtain up-to-date facts about clusters of tasks performed by farm operators engaged primarily in production of grain, livestock, dairy commodities, poultry, forest products, horticultural commodities, and general farming (Long, 1968). At the same University, another team of researchers (Mills and Rahmlow, 1966) sought to identify specific knowledges and clusters of knowledges most widely useful in major types of work commonly done by electronic technicians. Combinations of task-knowledge clusters suitable for use by curriculum planners in developing appropriate instructional programs and materials for office education were the focus of another study utilizing the cluster concept (Perkins and Byrd, 1966).

Comprehensive samples of office employees working in various sizes of offices involving twelve Standard Industrial Classifications were used to identify clusters of office tasks (Perkins, Byrd and Roley, 1968) in another research project. *Mathematics Clusters in Selected Areas of Vocational Education* (Rahmlow and Winchell, 1966) revealed five clusters of mathematics knowledge useful in all the job areas studied. These were: operations

with fractions, operations with decimals conversion of fractions to decimals, concept of percentage, and ratio and proportion. In another study (Rahmlow and Others, 1966) the clusters of knowledges and competencies associated with performance of food-service work were identified. Clusters of knowledges and competencies essential for effective performance of child-care work were determined in still another study (Rahmlow and Cavanagh, 1966). A sample of ninety-six leading-edge, child-care centers in four types of child-care agencies was selected for a study of the non-professional child-care occupations in order to further delineate the nature of this cluster (Rahmlow and Kiehn, 1967). Clusters of 279 items of knowledge in twelve allied health occupations resulted from the research (Wallenstien, 1968) of an investigator striving to identify these commonalities. A number of capabilities were identified as constituting a basic cluster for all youth who do not complete college (McCloskey, 1968).

At the University of Maryland another series of investigations were made relative to the cluster concept. A major research effort (Maley, 1966a) was concerned with the investigation and development of the cluster concept to a program in vocational education at the secondary school level. The cluster-concept program was aimed at developing skills and understandings related to a number of allied fields which would prepare the person to enter a family of occupations rather than a specific occupation. The investigator prepared summaries in three sections: appropriateness of the cluster concept program, development of occupational clusters, and, development of course outlines. In another report of this series (Maley, 1966b) information was provided on the analysis of job-entry tasks for carpentry, electricity, masonry, painting, and plumbing. Task statements were written in behavioral terms, and instructional sequences were developed from the task analysis.

Further developments of the investigation are reported (Maley, 1966c) relative to the cluster concept applied to electro-mechanical installations and repair. Each job-entry task (communication, measurement, mathematics, science, skills, and information) was analyzed for human requirements necessary to perform the task. Task statements were written in behavioral terms and instructional sequences were developed. A course outline was developed for metal forming and fabrication as part of the research on the cluster concept (Maley, 1966d). Selection and training of teachers in the use of the cluster concept was Phase II of this same project (Maley, 1967a). After the teachers were selected they were given three teacher-preparation sessions involving analyzing a job-entry task, writing behavioral objectives, and formulating a format for arranging instructional information. During the third quarter of this project (Maley, 1967b) a summer workshop for teachers preparing to use the concept was held. Evaluation of the first year of experimentation with the programs testing the cluster concept was provided in a summary of the total study (Maley and Mietus, 1968). The first phase of this research established the acceptability and feasibility of cluster programs and curriculums. Phase II resulted in the production of curriculum guides, course outlines, instructional materials, and

the selection and training of teachers to implement the programs. Phase III consisted of the evaluation of experimentation for the eleventh grade. Phase IV will be experimentation with the twelfth grade programs using the cluster concept.

Two releases from Oregon were concerned with the cluster concept. In a study of articulation of high-school and post-high-school occupational education in Clackamas County, some reference was made to the study of clusters of occupations (Mikalsen, 1967). A paper (McKinlay, 1968) discussed the job-cluster curriculum in Lane County. He identified the job cluster as consisting of these groups: service, distribution, production, business management, and technical-mechanical.

In an assessment of the occupational opportunities in Florida, job titles were clustered by subject areas. The four subject areas with large clusters in child care were: food, housing and home furnishings, clothing, and textiles (Ridley, 1967).

A study to identify the common core of knowledge and skills needed by technicians in the various phases of agriculture was conducted at Modesto Junior College (Halterman).

Clusters of competencies and job titles associated with entry and advancement in off-farm agricultural occupations were studied at Pennsylvania State University (Love, 1966). All data were analyzed for twelve competency and twelve job-title factors.

A curriculum research project (Sjogren and Sahl, 1966) centered on the problems of job clustering and identification of skills and abilities common to a number of jobs. The approach was to teach general skills, knowledges, and understandings for vocational training in a specific job. Two industrial classifications were defined for the study: agriculture related and non-agriculture related.

To identify a core of courses which management deemed desirable for most post-high-school technical programs was one of the purposes of a curriculum study in technical education (Arnold, 1965). A system of job families was established for the classification of respondents in which forty-six of the fifty-two technician jobs in the study had respondents. A general core of curricular recommendations was identified as agreed upon by respondents of all five job families. The implications of the general core were greatest in the mechanical family of technicians' occupations and less in the other four families (electro-mechanical, chem-mechanical, chemical, and chemical-foods).

A national study having as an objective the clustering of the major agricultural occupations with similar competencies provided significant insight into preparatory training needs in off-farm agricultural occupations (Taylor, 1966). The summarization, interpretation and resulting synthesis of the studies on agricultural occupations completed by twenty-six states provided the basis for determining extensions and adjustments in curricular patterns.

Tasks common to the job requirements of employees in three occupations (homemaker-home health aide, hotel-motel housekeeping aide, and nursing-

home housekeeping aides were determined by examining the mean score of the performance frequency for each task (Beavers and Shipley, 1967). Responses were calculated on a scale from one to three with all tasks having a mean score of 1.50 or above in all three occupations considered to be common.

A hierarchical clustering technique is described in a paper (Christal, 1966) which explains the grouping of people or things into mutually exclusive categories. The model begins with each of the N objects in a separate group. The number of groups is reduced by one at each stage until all objects are in a single group. The model groups objects into every possible number of mutually exclusive clusters from N to 1. The investigator then decides on the appropriate number of clusters to report by considering relevant factors. Applications of the model include: grouping job in a manner which minimizes average cross-training time among jobs within clusters, defining a large number of jobs with a fewer number of consolidated job descriptions, clustering technical schools into families, clustering judges in terms of homogeneity of their policy equation, grouping reading areas, grouping task clusters, and profile analysis.

The arrangement of occupations in homogeneous groups or clusters is one of the steps listed in a government publication (*Electronic Data Processing in Engineering, Science, and Business*, 1965).

Computer-Assisted Instructional Uses

Very little research was evident in studies dealing with computer-assisted instruction. However, in one study (Silberman, 1966) the possible solutions to the problem of the design of computer-assisted instruction programs were considered. The recommended answer to such problems is computer specialists and developing natural language programs for computers are means of helping educators to work with computers in instructional programs.

Another study (Silverman, 1966) describes an advanced computerized technique for clustering work tasks which was developed in research being conducted by this activity. With an input of tasks performed in a sample of jobs, this computerized technique produced a series of relatively homogeneous clusters of task patterns. These clusters represented the occupational specialties that existed in a field of work. This approach is useful for researchers concerned with clustering, classifying, and taxonomic techniques. The study focused on the development of a new computer clustering technique. The technical objective of the initial phase was to develop a computer method for arranging a number of individual task patterns, representing job incumbents in a given occupational area, into groups of clusters. A cluster was defined as a group of respondents characterized by relatively small differences in the kinds of tasks performed.

Project Plan

A publication (*The Project Plan for Distributive Education in Florida High Schools*, 1967) explains how to use the project plan in programs of dis-

tributive education. While this guide does not specifically emphasize the analysis approach, it does set forth a method for identifying occupational objectives and developing curriculums for the project plan.

Programmed Instruction

Two studies on curriculum building which used programmed instruction in the field of agriculture were recently completed at Washington State University (Long, 1966a; Long, 1966b). In the first, animal nutrition was developed as a programmed unit with the aid of sixteen vocational agriculture teachers. In the second study, the principles and procedures of land judging and plant nutrition were programmed. After completion of the programs, experimental use preceded the reporting of findings.

A linear program for a course in general electronics was developed and field tested (Valentine, 1965). Each learning sequence covered 200 to 300 frames. Written test scores for thirty-six conventional students, had a mean of 63 while the mean for fifty-nine programmed students was 82. The mean time for completing the course by these same groups was 120 hours and 140 hours, respectively.

Evaluation

A study to develop a model to evaluate ongoing pilot programs was designed utilizing the check technique (Tuckman, 1967). The model was based upon the Gagne technique of stating final course objectives in behavioral terms, and then subjecting these behaviors to an extensive task analysis. Results of the task analysis are presented in a behavioral hierarchy which schematically portrays the interrelationships among final course objectives and their behavioral prerequisites. Steps in this model include the identification of the final task and the sub-task, development of a hierarchy of sub-task, development of a written test using items from the sub-tasks, and administration and evaluation of the test.

A model for measuring the effects of a program geared to train disadvantaged youth is contained in another study (Austin, 1967). The primary focus of this report is the evaluation of the effects of the basic and vocational education program in the Muskegon Area Skill Training Center for disadvantaged youth.

Measures for assessing student achievement of instructional objectives of the experimental curriculum in the New Quincy, Massachusetts Vocational-Technical School were reported in the Sixth Quarterly Report of this project (Morrison, 1966a).

A doctoral study (Foley, 1967) was made to evaluate the adequacy of the measurement procedures of the two-year post-high school electronics technology courses throughout the United States. The results indicate that most of the job activities are taught to some level of proficiency but that little use is made of formal job-task performance tests to determine how well the student can perform each of these activities. This study indicates that pencil-and-paper tests are extremely poor substitutes for job-task performance tests and that the job validity of traditional theory is probably very low.

Summary

While several authors discussed the building of curriculums, few related curriculum building to analysis of jobs or tasks. Those that dealt with analysis frequently did so in a specific frame-of-reference which failed to either provide a complete treatment or an integrated approach. Some recent studies reflect progress in adapting concepts to applications of services other than that directly involved in the study.

SYSTEMS APPROACH TO BUILDING VOCATIONAL EDUCATION CURRICULUM

Today, the systems approach is applied to curriculum building. While some institutions are just discovering the implications of the process others are embarking on refinement of the process. The period since the close of World War II has brought startling innovations to the total process of curriculum building. While, at present, the systems approach has been validated and the merits of the concept thoroughly tested, for many individuals and institutions it is still just a theory of curriculum building.

A book that marks the coming of age of a systematic conception of the application of psychological principles to the invention, development, and use of complex man-machine systems is *Psychological Principles in System Development* (Gagne, 1956). It focuses on the many issues that relate to the human component or components in a system. As a theory of the psychotechnology of man-machine systems, it achieves integration of what has been called human engineering. At present, the Air Force, Navy, and Army have accepted widely the systems approach. The branches of the Armed Forces, as well as several researchers at universities, have investigated the systems approach. Human-factor scientists and specialists are attached to design teams, system-project offices, development groups, and system tests. System design begins with a statement of purposes for the system. Then systematic plans must be made for operation of the system. Next, the assignment of functions must be made. To best assign these functions to men it is necessary to perform task description, task analysis, and job design. This must be followed by job training or vocational education. The final step in the system is performance measurement. Basically there are four stages in systems development: design, development, testing, and operation.

Description of the systems approach as having inputs and outputs is contained in another helpful book (Borow, 1964). It explains how systems analysis has similarities to both group and organizational analysis but is more likely to deal with complex man-machine relationships and communications. Engineering aspects receive considerable attention in systems analysis. Task analysis and job analysis may be involved in the systems approach. With the growth of the systems concept, the term system analysis is being used with increasing frequency and often as a replacement for group and organizational analysis. He further explains how

systems analysis is performed. A list of all tasks is compiled, specific tasks are grouped optimally, a model may be constructed and simulators may be constructed. The author suggests that in the future the systems approach will also reflect the future as well as the present needs. He states that a master occupational storage and retrieval center is essential whereby the completion of a form which reflects interests, personality characteristics, aptitude patterns, educational background experiences, and many other elements of information will be required. To achieve these accomplishments, sophistication in occupational analysis will need to be greatly enhanced.

In an article in *Educate*, three authors (Tracey, Flynn, and Legere, 1968) suggest that systems thinking as applied to the improvement of military training programs can be used to upgrade schools in vocational education. They emphasize the need for a control model for proper management of the systems concept. Such a model is described in this article. The authors indicate that, over a four-year period of refinement, this model has reduced on-the-job training time, out academic failures, improved teaching efficiency, and reduced the over-all training time. The cycle starts by analyzing market needs and ends by evaluating the student after graduation. Three major phases in the cycle as envisioned by the authors are: determination of system requirements, system developments, and system validation. The model described consists of a 15-step curriculum system.

Public Education Innovations

Researchers at several universities and other institutions of education have explored the feasibility of using the systems concept in some form in vocational curriculum building.

A massive effort has been made at Washington State University to research this approach. In a report (Byrd and Christensen, 1968) of a prototype multi-media self-instructional system relative to teaching Gregg shorthand, a plan was developed for modernizing and enriching these instructional programs in small schools. Prototype components and the other elements essential for a retailing instruction system for distributive education were the result of another research effort (Ertel, 1968). Development and testing the systems approach in the field of electric arc welding resulted in a self-pacing multimedia, self-instructional system (Sergeant, 1968). A similar system was developed and tested relative to electrical knowledges and capabilities (Hill, 1968). Still another research (Nish, 1968) developed and tested a self-instructional polysensory system comprised of four single-concept films, programmed books, and laboratory work experiences associated with the teaching of expandable polystyrene plastics. Results indicated that such a system is an effective means of enabling pupils to acquire knowledge, manipulative skills and judgments of the types taught by the system.

A broad study was conducted of the developmental procedures and costs of the newer media prepared for course instruction at Michigan State University (Dresse and Others, 1965). As reported in seminar papers, the study included the relationship of systems methodology to university curricular

and instructional planning. Attention was focused on analysis, design, and field trials. The functions of the media specialist were also studied.

An investigation of self-instructional materials was conducted under a grant to the Oregon State System of Higher Education (Hamreus, 1967). The purpose was to plan and produce an improved instructional system. Eleven steps of the system design were outlined in the report.

A systems approach using models designed by Systems Network Analysis Process (SNAP MAPS) was tested by another researcher (Yoho, 1967). The theory of teaching and learning for this system approach is based upon developing individual self-motivation and self-discipline and upon creating a whole which the student must synthesize and relate into understanding.

The requirements of a systems approach are described (Welch, 1968) as including: identification of tasks, breakdown of tasks into operations, determination of method, training for performance of tasks, and control to see that the tasks are carried out. The investigator applied this approach to the tasks of the food-service industry.

Simulation on a computer was part of a system approach for an experimental biology course at Theodore High School at Theodore, Alabama (Bratten, 1966). The simulation followed analysis and projected the results expected from the use of the proposed curriculum

A systems analysis was made for a 10th grade social studies course at Nova High School, Fort Lauderdale, Florida, to evaluate the course as an instructional system. The analysis was concerned with such problem areas as teacher roles, the effects of media on student-teacher relationships, information requirements, the use of space, and the effects of course procedures on students. A computer simulation model of the course was set up and tested. Testing of the data produced by the model against the data that were descriptive of the course proved the simulation procedures to be valid (Cogswell, 1966).

The goal of another study (Silvern) was to determine the feasibility of developing a model to describe real-life feedback signal paths from outside the secondary school to an occupational teacher. Data used to synthesize a flow chart model were collected in interviews with educators, occupational directors, students, and other professionals. The cybernetic model included forty-nine closed-loop feedback signal paths, each identified in terms of five characteristics which in turn affected instructor performance. The model was shown to be feasible and applicable to real life.

Illustrative of the work being done at the state level in Washington (Wimer, 1967) is the report of the Coordinating Council for Occupational Education on training requirements and specifications for data processing technology. This system approach includes the following six phases: investigation and feasibility study, design, development, implementation, production, and follow-up. Functional diagrams were developed to illustrate each of the main steps of the process in addition to that which analyses by data processing provided.

The general schema for designing relevant training programs was described in a recent article (Crawford, 1968). The seven-step approach con-

sists of: develop human factors systems analysis model, develop job model, specify knowledges and skills, determine instructional objectives, construct training program, develop proficiency test, and evaluate training program. If the portion of students who meet the performance standards is not satisfactory, it is "back to the drawing board" for a redesign of the curriculum.

Armed Forces Innovations

Research in the Army, Navy, and Air Forces has contributed much to the literature of the systems approach and its application to the building of training and educational programs.

Guidelines (Chenzoff and Folley, 1965) for instruction in three phases of Training Situation Analysis (TSA) provide the plan for systematically gathering and interpreting the information which is relevant to the planning of training and training devices. Three phases of Training Situation Analysis are described in detail. The first, systems familiarization, provides an orientation to the training problem, the system structure and flow, and the equipment. Task analysis method, the second phase, produces a set of task descriptions containing the information necessary for making training device decisions. In the third phase, training analysis procedure, a ranking of tasks is achieved based upon the potential benefit to system performance as a result of training and the costs of that training. Recommendations for the conduct of these three phases and suggested working forms are presented in the guidelines.

The Systematic Approach to Multidimensional Occupational Analysis (SAMOA) is described in several documents (Carr and Silverman, 1966; Carr, 1967; and Carr, 1968). The SAMOA method consists of three major steps. First is the development and administration of comprehensive task lists and related data-gathering forms. The second step is the computerized analysis of the data on tasks and task patterns. This is accomplished by a clustering program which identifies homogeneous work groups on the basis of similarity of patterns of tasks performed. The third major step is a set of computerized procedures for stratifying and grouping clusters on the basis of significant variables within three dimensions of the work situation. These dimensions are technical, organizational, and communicational. The SAMOA method provides a very rapid means for analyzing work-requirement data. The major phases of the method are independent so that data pertinent to any one of the three dimensions can be analyzed separately. The basic analytical unit is a cluster of men whose patterns of tasks performed exhibit a maximum degree of compositional homogeneity, as determined by a computer clustering program, which generates multiple coefficients of compositional similarities.

The United States Air Force (Morsh, 1964) has developed and applied a novel procedure for collecting, organizing, analyzing, and reporting comprehensive job information. The procedure combines features of the checklist method with those of the open-ended questionnaire and the observation interview into a single-integrated procedure. The Air Force job analysis

procedure involves a sequence of discrete steps: location of source materials; draft of job inventory; review of draft by advisors; revision; field review; construction of operational job inventory; selection of survey sample; mailing; administration of job inventory; responding to inventory; scanning, coding, and collating; key punching and verifying; computer analysis; and distribution of survey results. Another report (Eckstrand, 1964) provides an overview of the process of designing a training system. The three main areas of the process are determining training requirements, developing training environment, and measuring the results of training. Learner-Centered Instruction (LCI) is described in another report (Pieper, Folley, and Valverde, 1968). Behavioral descriptions serve as a basis for the preparation of statements of learning objectives and a performance-criterion test in the development of Learner-Centered Instruction courses. The behavioral task description was completed in two phases: data collection and behavioral analysis. This information later becomes the basis for training content in LCI courses. These become highly job-relevant and include multimedia, self-instructional, apprentice-like experiences. The effectiveness of the LCI approach is being tested at Lowry Air Force Base (Valverde, 1968).

A report (Ammerman, 1966) of the research findings of the Human Resources Research Office (HumRRO) disclosed a system for analyzing instructional objectives by identifying factors that influence their meaningfulness and usefulness. A survey of eight army service schools was conducted to determine procedures used by instructional personnel in deciding course content. The findings indicated that the relevance of student action in converting existing instructional topics to the form of student performance objectives have suffered from lack of thorough definition of intended work-performance situations. Distinction was made between terminal objectives (representations of the ultimate expected performance capabilities) and enabling objectives (necessary learning tasks dependent upon terminal objectives for their value). A summary of the state-of-the-arts (Smith, 1966) as to the aspects of the technology for developing training systems is found in another HumRRO report. The report is based on a survey of the available literature and draws particularly on HumRRO experience in research studies on training. Covered in the report are: the instructional system as a concept, the research evidence bearing on the major system functions, and the methods for designing and evaluating the system in terms of both cost and effectiveness.

A systems approach to education described as a "systems-science flavor" was utilized in a research project at Battelle Memorial Institute (Coffey, 1968). The major objective was to evaluate the efficiency and effectiveness of self-instructional methods for selected areas of vocational education. Two major work phases were conducted. The first was directed toward a very detailed analysis of trade and industrial education for the purpose of identifying and describing primary vocational skills to be used as the basis for subsequent development of self-instructional units. The final activity of the basis for evaluation of self-instructional methods. The conclusion was

reached that the self-instructional system is a significant method for improving the efficiency and effectiveness of vocational education. A second important conclusion was that primary vocational skills, as conceived, simply do not exist at the vocational education level. Primary skills are those skills having wide applicability across trades.

The uses of systems analysis and computer simulation of school organization were explored (Cogswell, 1966) to find new ways to implement instructional media.

The use of program evaluation and review technique (PERT) with implications for curriculum building may be gained by studying several reports (Arnold, 1966; McKee, 1966; and Hitchcock and Bliss, 1964). McKee documented the steps in the building of curriculums for a new college using the PERT method. Arnold explained the use of PERT in planning a program of dental continuing education and various other health-education projects. Hitchcock and Bliss characterized PERT as a dynamic and responsive project-management system useful in planning, controlling and evaluating.

A Job Corps manual (Butler, 1967) develops the concept and the use of the systems approach. This approach involves the accurate identification of the requirements and problems, the setting of specific performance objectives, the application of logic and analysis techniques to the problems, the development of methods for the solutions of the problems, and the rigorous measurement of results in comparison to the specific performance objectives. According to the manual the same systems engineering techniques so successfully applied to the development of hardware have also been applied to training course development problems. It is used to describe a training system as a series of interrelated, interacting, precisely controlled learning experiences that are designed to achieve specific training objectives, but organized into a unified, dynamic whole which is responsive and adaptive to the individual trainee while fulfilling specific job-relevant training criteria.

According to another Job Corps publication (*Instructional Systems Development Manual,* 1968) an instructional system is both a product (a complete instructional package) and a process (a method for designing the package). The application of good systems engineering principles along with those of programmed instruction to the entire curricula has introduced empirical methods for the analysis, design, development, and evaluation of education and training. The emerging instructional systems technology demands that all training course design decisions be based on statistical analysis of trainee performance data. Each step in the development cycle must be empirically tested and validated against actual performance data. The training course developer now has a tool for determining the validity of training objectives, content, sequence, method, media, and achievement.

Annotated bibliographies (Morsh, 1962; Smith, 1964; and Valverde, 1968) provide an excellent source of information relative to specialized studies on job analysis, training objectives, and training media.

Summary

A few vocational educators, psychologists, university researchers, and investigators for the Armed Forces have devoted considerable effort to de-

veloping a systems approach to building vocational education curriculums. The initial step usually consists of analysis of the job requirements or the determination of the systems requirement. This is followed by systems development and systems validation.

TRENDS AND NEW DIRECTIONS

New developments have been mentioned in the various sections of this review. However, it seems desirable to consolidate some of the illustrations to explore the road ahead in curriculum development. It has been most encouraging to note the vigor of the movement towards a firmer foundation for vocational and technical curriculum building by a more careful and realistic analysis of information basic to acquiring entry-level skills. It has been gratifying to note the intensity of the effort concentrated by the Armed Forces and some of the leading colleges and universities towards a systems approach with a validation of the system. However, it is quite discouraging to see the small amount of concern from some of the sectors. Many educational institutions at various levels are conspicuous by the lack of contribution or lack of identification with such movements.

At the risk of omitting several worthy and outstanding contributions the author would like to mention some of the studies, reports, and books that highlight the forward motion characterized by many others. It is not the purpose in this section to build a solid synthesis but rather to use some references as illustrations in the hope that they may provide further incentive for even greater developments in the future in broadening the base and reinforcing the foundation of analysis for curriculum building in vocational and technical education.

Illustrations of the advanced thinking in this field are reflected by the authors of two books (Gagne, 1966; Borow, 1964). Both deal with the systems approach to the problem. Gagne opens up the theory of psychotechnology of the man-machine systems and reveals many validated psychological principles highly desirable for progress in a complex system of analysis. Borow sees occupational analysis and its applications as having just begun and recognizes the tremendous potential of the future untapped resources available.

Tracey and Flynn (1968) point out the successful achievement of a tested system with a control model in reducing training time, cutting academic failures, and improving teaching efficiency.

Morgan and Bushnell (1965) point to the problems and shortcomings associated with our present-day programs of education and indicate a need for radically modifying the system in order to design an educational program which will be responsive to the present-day needs of students. The organic curriculum is suggested for consideration. The first step in building a student-centered, organic curriculum is the determination of specific and measurable behavioral attainments needed for entry into a variety of post-high school activities. Such a program is pictured as including academic and occupational training, personal development, real-work experience, personal

and vocational counseling, and social and recreational activities. The integration and interaction of these components result from careful systems design. These writers recognize that research and development efforts in curriculum have been small and fragmented, to date, and that a massive research effort will be required to develop and validate an organic curriculum.

Individually paced or programmed instruction (Valentine, 1965) demands a firm footing in analysis. It requires training objectives in closer agreement with the skills and knowledges required.

As a result of a comprehensive study (Christal, 1968) the decision was reached that some type of task inventory survey procedure had the greatest probability of satisfying the requirements of a sound occupational world. Learning media (Green, 1966) are important in dealing with innovations in educational considerations given to designing curricula. Included in this part of the process are such concepts as independent learning, elective sequences, core curricula, and learning systems analysis.

Systematic planning of school curriculums (Sand, 1966) can be innovative, particularly when built upon a comprehensive conceptual scheme.

An emerging coordinated systems approach on a state-wide basis, with flexibility and a built-in feed-back loop offering far-reaching implications for curricula geared to the needs of students and the needs of employers, is evident in one of several curricula now in process (Wimer, 1967).

Performance proficiency measurements (Foley, 1968) are requirements of a total approach to an integrated curricula system.

On a broader horizon, citizens of the community also have concerns in evaluation (Hamlin, 1967). Dr. Hamlin said, "It is a great misfortune that the best trained evaluators have been looking at education with a microscope rather than a panoramic view finder . . . . Typically the evaluations have been of programs, teachers, students and former students, and facilities. There has been little attention to public policies and public attitudes responsible for the conditions discovered or to the processes by which public policies for occupational education are derived."

The elements of a composite system of curriculum development using the advantages of research are now known and tested. Ample research findings have provided a base from which a multiplier effect is possible. Application to all services, fields, and institutions of education through curriculum building in keeping with the known state-of-the-arts may be the direction of the movement, but the evidences of such implementation are slight as revealed in a thorough and painstaking search of the literature and research. However, the movement has started and bright stars are becoming visible behind the dark clouds of uncertainty revealing the horizon of some curriculums built on the foundation of occupational analysis.

Summary

Slow progress has been made towards the process of building vocational education curriculum on analysis. The present trend reflects improved analysis methodology, broader application to all services, and greater attention to the development of a systems approach to curriculum building.

Conclusions

Training and education of youths and adults for jobs and of employers for qualified personnel demands more serious consideration be given to:

1. Increasing use of analysis as the foundation for vocational curriculums.
2. Codifying and defining terms used.
3. Developing common understandings of effective processes of analysis.
4. Accepting of procedures found functional by other vocational services.

Recommendations

1. Progress in vocational education curriculum validation is directly dependent upon analysis. Therefore, large-scale use of analysis for all services is essential for improvement of program planning and instruction in vocational education.

2. A united and coordinated massive effort is mandatory to provide validated vocational curriculums for existing and emerging occupations. Further study should be made now to determine how this can best be achieved. It may be that one or more centers should be established with the unique function of curriculum building. Such a center must have:

   a. Competent professional staff having command of the total process of analysis and curriculum building.
   b. Hardware in the form of computers and other aids as well as the software needed.
   c. Effective methods for dissemination to potential users.

It is questionable if large-scale use will ever be made of validated curriculum if each teacher must build his own curriculum on his own analysis process.

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